22st Annual National Test & Evaluation Conference

Jacksonville, FL

6-9 March 2006

On-Site Agenda
Final Attendee Roster

Monday, 6 March 2006

Tutorials:

How to Improve the Effectiveness, Efficiency, and Integration of Test & Evaluation (T&E) and Modeling and Simulation (M&S), by Dr. Mark J. Kiemele, Air Academy Associates

Putting the Missions and Means Framework (MMF) to Work to Drive Analysis - Getting to the "So What" by Asking the Right Questions about the Mission and Generating Complete and Relevant Answers, by LTC Britt Bray, USA(Ret), Dynamics Research Corporation, Inc. and Mr. Bill Yeakel, President, ORSA Corporation

Tuesday, 8 March 2005

Modeling, Simulation and Testing: Collision Course or Happy Marriage?, by Hon Philip E. Coyle, III, former Director, Operational Test & Evaluation (DOT&E), OSD

Panel: Non-Technical Obstacles to Technical Obstacles to Effective M&S Connectivity in Effective M&S Connectivity in Support of T&E:

Panel Chair: Mr. John Illgen, Northrop Grumman Simulation Technologies
Panel:DT&E's Perspectives - "Making M&S and T&E Better Partners":
Panel Chair:
- Mr. Chris DiPetto, Special Assistant, Systems Engineering, Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics Technologies

Panelist (Government Representatives):
- Dr. George Kailiwai, III, AFFTC Technical Advisor
- Mr. Thomas Berard, Director, White Sands Missile Range

Panelist (Industry Representatives):
- Mr. Steven E. Cameron, Senior Manager, Modeling & Simulation Infrastructure, Boeing Analysis, Modeling, Simulation & Experimentation
- Mr. James A. Hazlett, Director, Mission Profiling, Mission Innovation, Raytheon Integrated Defense Systems

An LFT&E Perspective on Making M&S and T&E Better Partners, by Dr. Lowell Tonnessen, Institute for Defense Analyses

Modeling the FCS Brigade Combat Team in a Stability and Reconstruction Operations
Mission – Implications for T&E Planning, by LTC (R) Britt E. Bray, Dynamics Research Corp.

T&E Transformation - "We Don't Need a More Formal Invitation", by Mr. William P. Yeakel, President, ORSA Corporation

Wednesday, 8 March 2006

DMSO Panel*:*
Panelist:
- Challenges For M&S in Army Test and Evaluation, Mr. Roe Mirabelle, Chief, Technical Support Division (TSD), Modeling & Simulation

Military Services Perspectives:

COMOPTEVFOR Perspectives on Modeling & Simulation in Operational Test & Evaluation, RADM Bill McCarthy, USN, COMOPTEVFOR

The Air Force's Perspective, Mr. Jack Manclark, AF/Test & Evaluation Directorate
M&S Support to FCS

M&S Studies in the Context of the T&E and Acquisition:

Diagnosis of the Problem: What Prior Studies Have to Say, by Dr. James E. Coolahan, Program Manager and Modeling and Simulation Group Supervisor, National Security Analysis Department

"Open Air Testing vs. Modeling and Simulation: At last Peaceful Coexistence?", by RADM Charles "Bert" Johnston, USN (Ret), Vice President & General Manager, Wyle Laboratories
Live-Virtual-Constructive Distributed Environments in Support of Test and Evaluation, by Major Kelly A. Greene, Ph.D., Air Force Agency for Modeling and Simulation

Open Technology Development & Testing, by Mr, John Scott, OSD, AS&C Consultant

Modeling and Simulation of System of Systems The History of the LPD 17 PRA Testbed, by Mr. Vincent M. Ortiz, AVW Technologies

Thursday, 9 March 2006

Using the Missions and Means Framework to Generate Cost-Effective Live-Fire Test and Evaluation Strategies, by Dr. Martha K. Nelson, Franklin & Marshall College, Department of Business, Organizations, and Society & Mr. Dennis C. Bely, US Army Research Laboratory, Survivability/Lethality, Analysis Directorate

Modeling and Simulation to Advance Test and Evaluation, by Dr. Sheldon Tieszen & Dr. Lou Gritzo, Sandia National Laboratories

Track 1:

T&E / M&S Architecture:
- Test and Training Enabling Architecture (TENA) Offers Range Interoperability and Resource Reuse Solutions for Test and Training Ranges, by Mr. Gene Hudgins, TENA User Support Lead
- A Case Study of T&E Data Supporting A Simulation by Mr. Vincent M. Ortiz, AVW Technologies

Policy Proposals:
- 27 Steps to Success: The DoD Acquisition M&S Master Plan, by Mr. Fred Myers, OUSD (AT&L) DS/SE, Chair, Acquisition M&S Working Group
- "No More Second Opinions: Organizing DoD M&S Within the Acquisition Cycle" by Mr. James F. O'Bryon, The O'Bryon Group
- Optimizing Cost & Time Effectiveness of Test & Evaluation Using Knowledge-Based Simulations, by Dr. Keith S. Bradley, Lawrence Livermore National Laboratory

Track 2:

(VVA) "V,V&A" Issues to Make T&E/M&S Work Effectively:
- LPD 17 PRA Testbed VV&A Database: A Disciplined Approach for VV&A, by Mr. Vincent M. Ortiz, AVW Technologies

Examples of Attempts to Get Mutual Support Between T&E and M&S:
- Dual Thrust Modified Smokey Sam for Low Cost Testing and Simulation, by Mr. William R. Taylor, Tech Advisor for EOCM, AFRL/SNJW
- Integration of Transport Modeling with Test and Evaluation in CBR Building Protection Programs, by Mr. James Risser, Battelle

M&S Studies in the Context of the T&E and Acquisition:

- CAW use of M&S in Support of Maritime HLD/HLS/ATFP Test and Training Exercises, by Mr. Arman Tchoubineh, NAWC WD, Pt Mugu, CA

- Commericial Air Services: Live Test Assets for Electronic Warfare, by Mr. Stan Ulkoski, PMA-207D2 Aircraft Operation Manager, J.F. Taylor, Inc., NAVAIR Support Contractor

22nd Annual National Test & Evaluation Conference

"Improving the Test and Evaluation of Defense and Homeland Security Systems Through Effective Development and Intelligent Application of Modeling and Simulation."

March 6-9, 2006
Hyatt Regency Jacksonville
Jacksonville, FL

Event #6910

Sponsored by:
National Defense Industrial Association
Test & Evaluation Division in Cooperation
with the NDIA Procurement Division and
NDIA Systems Engineering Division

NDIA
NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

On-Site Conference Program

Personal Note to Conference Participants from the T&E Executive Committee:

Thank you for attending our conference in Jacksonville. We appreciate your making this meeting a priority and for you're taking the time to travel to be with us. Whether you're a speaker, exhibitor or simply a delegate, we hope that you'll feel welcomed and that you'll fully participate in all of the activities planned. If you come with friends or family, there are a couple of events scheduled which they are also welcome to attend at a additional nominal fee.

The topic the Executive Committee has selected for this 22nd Annual National T&E Conference is very timely and is one that requires answers and action. As always, we have scheduled an outstanding roster of nationally known speakers, including those drawn from industry, military, civil service and academia who will be addressing our theme issues from various directions.

The tutorials scheduled for Monday are offered at no additional charge to those who are registered for this conference. We encourage you to avail yourself of this additional opportunity to learn in more depth about a number of T&E initiatives.

Also, we are again going to recognize those who are worthy of commendation for their achievements in the world of test and evaluation. Plan to join us for both award events, the first on Tuesday evening and the second on Wednesday noon.

We hope that you'll also spend time in the display area becoming aware of what the T&E marketplace has to offer in the way of products, services and programs.

Jacksonville, FL is a beautiful city. Stop by the NDIA registration desk for information on what Jacksonville has to offer.

Jim O'Bryon, Chairman, NDIA T&E Division

NDIA TEST AND EVALUATION DIVISION

The Test and Evaluation Division was initially established under the auspices of the American Defense Preparedness Association (ADPA). With the merger of National Security Industrial Association and the American Defense Preparedness Association on March 1, 1997, the T&E Division and its responsibilities were transferred to the National Defense Industrial Association. It is one of 30 divisions of the NDIA.

NDIA TEST AND EVALUATION DIVISION OBJECTIVES

NDIA's principal missions are to improve weapons technology, improve defense management, and maintain a strong science-industry-defense team continually responsive to all needs of the research, development, test and evaluation, production, logistics and management phase of national preparedness. It provides a forum for the exchange of ideas and information between its members and government agencies through a network of divisions, chapters, national and local meetings, and conferences and visits to Department of Defense installations. Consistent with, and in furtherance of, the By-Laws and policies of the NDIA, the objectives of the T&E Division with respect to those government elements appropriate to its field of interest shall be:

Ensure the continuation, responsiveness, and where necessary, the revitalization of the industrial base to support our national security by:

- Maintaining effective liaison with the Department of Defense, Executive and Legislative Branches of the Government, and other governmental departments and agencies to apprise appropriate representatives of these organizations of T&E Division activities and keep abreast of current and future developments.

- Reviewing, evaluating, and providing recommendations with regard to government policies, practices, directives, and specifications including pending legislation concerning life cycle logistic support, supply chain integration, strategic and tactical mobility, and business processes.

- Serving as a catalyst for community dialogue among T&E communities within government, industry and academia as well as provide an overarching means for dynamic interchanges of information with other functional areas.

- Sponsoring government/industry meetings, seminars, and symposia to provide effective communications between government and industry relative to management activities for which the T&E Division is responsible under this matter.

- Maintaining viable liaison with other divisions of the NDIA, other associations, and national - level industry coalitions for the purpose of exchanging information of mutual interest and coordinating and cooperating on activities requiring Joint participation.

- Developing strategic directions effecting T&E partnerships between national security industries and government and to formulate proposals for national policies, addressing their impact on the national security industrial base.

- Establishing and maintaining a productive proactive dialogue with the national news media.

- Fostering learning of the basics and advanced concepts and techniques of T&E within the defense industry including the cross - pollination of commercial approaches to T&E for the defense community.

- Commemorating and recognizing services rendered by individuals, companies, and government agencies in meritorious acts related to activities enumerated above.

The Walter W. Hollis Award

The Walter W. Hollis Award is presented annually in recognition of lifetime contributions and achievement in the area of defense Test and Evaluation. The Award is presented in the name of Walter W. Hollis who is recognized for his dedicated and long-standing service in the field of Test & Evaluation.

Previous Recipients

2005 Hon Thomas Christie, DOT&E, OSD
2004 Dr. Marion L. Williams, Headquarters AFOTEC
2003 Mr. James W. Fasig, Aberdeen Test Center
2002 Mr. G. Thomas Castino, Underwriters Laboratories, Inc.
2001 Hon Philip E. Coyle III, DOT&E, OSD
2000 Mr. Walter W. Hollis, Department of the Army

MONDAY March 6	TUESDAY March 7	WEDNESDAY March 8	THURSDAY March 9
Registration Hours			
7:00 AM - 5:00 PM	7:00 AM - 6:30 PM	7:00 AM - 5:15 PM	7:00 AM - 3:00 PM
Display Hours			
Set-Up 11:00 AM - 5:00 PM	7:00 AM - 8:00 AM	7:00 AM - 8:00 AM	7:00 AM - 8:00 AM
	10:15 AM - 10:45 AM	9:45 AM - 10:15 AM	10:00 AM - 10:45 AM
	12:15 PM - 1:15 PM	11:45 AM - 1:15 PM	12:00 PM - 1:00 PM
	2:45 PM - 3:15 PM	2:45 PM - 3:15 PM	2:30 PM - 3:00 PM
	6:30 PM - 8:00 PM		

AGENDA

MONDAY, MARCH 6, 2006

7:00 AM - 5:00 PM Conference Registration

11:00 AM - 5:00 PM Displays Set-Up

1:00 PM - 4:45 PM Tutorials (These tutorials are offered at no extra cost to all registrants)

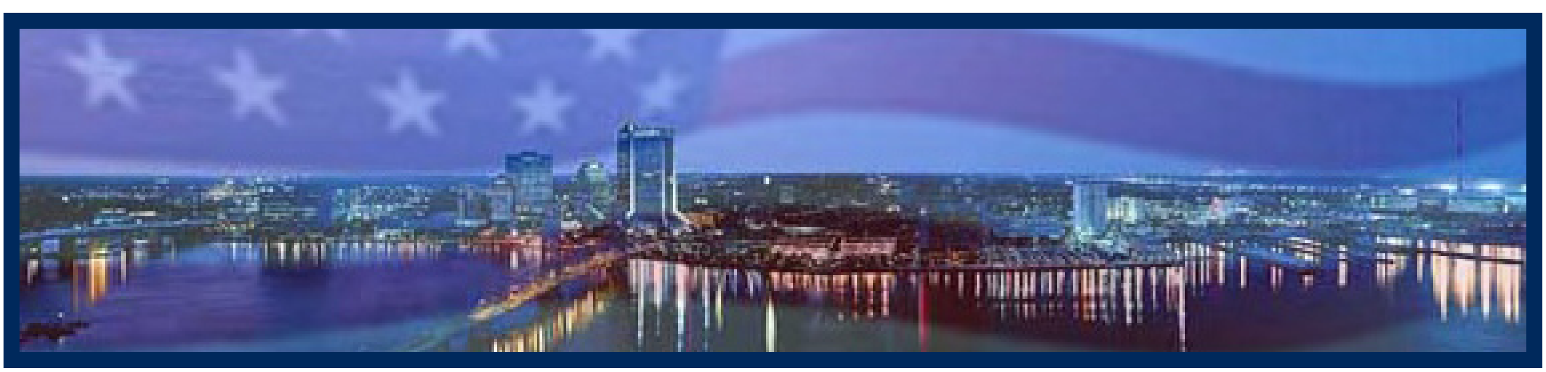
TRACK I	1:00 PM – 2:45 PM	Break	3:00 PM – 4:45 PM
	"How to Improve the Effectiveness, Efficiency, & Integration of Test & Evaluation (T&E) & Modeling & Simulation (M&S)," *Dr. Mark Kiemele, Air Academy Associates (PART 1)*		"How to Improve the Effectiveness, Efficiency, & Integration of Test & Evaluation (T&E) & Modeling & Simulation (M&S)," *Dr. Mark Kiemele, Air Academy Associates (PART 2)*
TRACK II	*"Putting the Missions and Means Framework (MMF) to Work to Drive Analysis - Getting to the "So What" by Asking the Right Questions about the Mission and Generating Complete and Relevant Answers. A Practical Tutorial on MMF Application," LTC Britt Bray, USA (Ret), Dynamics Research Corporation, Inc.; Mr. Bill Yeakel, President, ORSA Corporation (PART 1)*		*"Putting the Missions and Means Framework (MMF) to Work to Drive Analysis - Getting to the "So What" by Asking the Right Questions about the Mission and Generating Complete and Relevant Answers. A Practical Tutorial on MMF Application," LTC Britt Bray, USA (Ret), Dynamics Research Corporation, Inc.; Mr. Bill Yeakel, President, ORSA Corporation (PART 2)*

4:45 PM Tutorial Sessions Close

5:00 PM Conference Registration Closes (Registration will re-open tomorrow at 7:00 AM.)

There is no scheduled function this evening. Please stop by the registration desk for a listing of local dining options, entertainment, shopping, etc.

Your attention please: Survey sheets will be given to every conference registrant upon arrival. The survey sheets are intended to gather your thoughts and ideas regarding this NDIA T&E Conference. Registrants are requested to thoughtfully complete these surveys and return them to the NDIA desk prior to their departure. The results of these surveys will be used to serve as a basis in planning for future conferences and should be completed.



Jacksonville Skyline

TUESDAY, MARCH 7, 2006

7:00 AM		Registration Opens
7:00 AM		Continental Breakfast in Display Area
8:00 AM		Call to Order, *Mr. Sam Campagna, NDIA*
8:05 AM		Presentation of the Colors and National Anthem
8:10 AM		Welcome and Opening Comments, *Mr. James O'Bryon, Chairman NDIA Test and Evaluation Division*
8:15 AM		Conference Keynote Address, *Gen Larry Welch, USAF (Ret), former President, IDA & former Chief of Staff, USAF*
8:55 AM		"M&S and Testing: Collision Course or Happy Marriage?, " *Hon Philip E. Coyle, III, former Director, Operational Test & Evaluation (DOT&E), OSD*

Session #1
PRESENTATION OF THE ISSUES
Host: Mr. Larry Graviss, Chairman, NDIA ICOTE Committee, Jacobs Sverdrup

9:30 AM		ICOTE Editorial Report: "Assessment of Large-Scale Distributed Engineering M&S Plants," *Mr. Jim Sandberg, Northrop Grumman; Mr. Michael Crisp, ODOT&E*
10:15 AM		Break in Display Area
10:45 AM		**Panel** "Addressing Non Technical Obstacles to Effective M&S Connectivity in Support of T&E" Panel Chair: *Mr. John Illgen, Northop Grumman* *Panelists:* *Mr. Rick Cozby, DTC* *Mr. Jack Sheehan, FCSCTO* *Mr. Augustine Ponturiero* *Mr. Peter Shaw* *Dr. Paul H. Deitz, ARL*
12:15 PM		Luncheon

Session #2
Host: Mr. Dick Dickson, Tybrin Corporation

1:15 PM		**Panel** "DT&E's Perspectives on Making M&S and T&E Better Partners" Panel Chair: *Col Richard Stuckey, USAF, Acting Deputy Director, DT&E, OUSD(AT&L)* Panelists (Government Representatives): *Dr. George Kai'liwai, Technical Advisor, AFFTC Edwards AFB, CA* *Mr. Thomas Berard, Director, WSMR* Panelists (Industry Representatives): *Mr. Steven Cameron, Lockheed Martin* *Mr. James A. Hazlett, Raytheon*
2:45 PM		Break in Display Area

TUESDAY, MARCH 7, 2006 (Continued)

Session #3
Host: Dr. Juan Vitali, ATEC

3:15 PM	"DOT&E Perspectives," *Mr. David Duma, Acting Director, Director Operational Test & Evaluation*
3:45 PM	"An LFT&E Perspective on Making M&S and T&E Better Partners," *Dr. Lowell Tonnessen, IDA*
4:15 PM	"Modeling the FCS Brigade Combat Team in a Stability and Reconstruction Operations Mission Implications for T&E Planning," *LTC Britt Bray, USA (Ret), Dynamics Research Corporation*
4:45 PM	"Transformation In TD&E," Mr. Bill Yeakel, President, ORSA Corporation
5:15 PM	Afternoon Session Closes
6:00 PM	Reception
6:30 PM	Honors Banquet- The cost of the banquet is included in the conference registron fee. Guests (non-conference registrants) are also welcome to attend this banquet for an additional fee. Reservations must be made at the NDIA registration desk by Monday, March 6, 2006 at 5:00 PM.

Guest of Honor
This event has historically been a highlight of our National NDIA T&E Division Annual Conference and this year is no exception. Our 2006 recipient of the Walter Hollis Award for Lifetime Achievement in Test and Evaluation is RADM Charles "Bert" Johnston, USN, (Ret).

RADM Bert Johnston's T&E involvement extends more than 30 years including time with the US Navy as a Test Pilot, Program Manager, Systems Engineer, and a host of other positions in the U.S. and abroad. He has served with distinction in senior testing positions in Australia, Pax River, China Lake and more recently as Commander, Naval Weapons Center, Weapons Division, China Lake, CA.

In January 2002 he became Vice Commander for the Naval Air Systems Command. He continued to stay involved in testing, supporting the integration of joint capabilities and the expanded use of test facilities for rehearsal, demonstration, training, and experimentation. His transition from the Navy in the Spring of 2005 wasn't the end of his involvement with testing. He now serves as Vice President and General Manager for the Systems Engineering Division of Wyle Laboratories, Naval Aviation's largest support contractor. Among his responsibilities are Wyle's Flight Test Operation and the Telemetry Data Systems. Congratulations from all of us for a job done well!!

Guest Speaker

VADM Bennitt (Ret), USN has flown over 4000 hours in more than fifty different aircraft types and models. He graduated from the U.S Naval Academy in 1964 and was designated a Naval Aviator eighteen months later. After two combat cruises and 222 combat missions with Attack Squadron 94, flying the A-4 Skyhawk aboard USS HANCOCK and USS BONNE HOMME RICHARD, he attended the U.S. Naval Test Pilot School and served as an Aircraft Carrier Suitability Test Pilot at the Naval Air Test Center. This assignment was followed by a tour as a flight test tutor at the Empire Test Pilot School at Boscombe Down, England, during which he was commended by the Queen of England for valuable service in the air as the school's Stall/Spin Program Manager and as one of the development test pilots on England's first variable stability training aircraft.

Vice Admiral Bennitt was later assigned to Washington, DC where he served as Acting Director of Aircraft Carrier and Air Station Programs in the office of the Chief of Naval Operations. He then received orders as Commanding Officer, USS NIMITZ, taking command on August 28, 1987. In September 1989, Vice Admiral Bennitt was assigned as Deputy Director, Test and Evaluation and Technology Requirements (OP-091B) in the office of the Chief of Naval Operations. In November 1991, he returned to the fleet to take command of Carrier Group FIVE and Battle Force Seventh Fleet, home-ported in Yokosuka, Japan. In October 1993, Vice Admiral Bennitt was assigned as Director, Air Warfare Division in the office of the Chief of Naval Operations. He then assumed command as Commander, Naval Air Force, U.S. Pacific Fleet in January 1996. For his contributions to flight safety during that tour the International Flight Safety Foundation selected him as the 1998 recipient of the Laura Taber Barbour International Air Safety Award.

Mr. Bennitt is now Executive Vice President and General Manager of the Wyle Aerospace Group. He also serves as a National Director of the Navy League of the United States.

Plan to attend our banquet and enjoy the evening and pay tribute to this year's honoree.

WEDNESDAY, MARCH 8, 2006

7:00 AM	Registration Opens
7:00 AM	Continental Breakfast in Display Area
8:00 AM	Call to Order and Administrative Announcements, *Mr. Sam Campagna, NDIA*
8:00 AM	Focus on our Customers (Video)

Session #4
LOOKING AT THE FACTS
Host: Mr. Bill Yeakel, ORSA Corporation

8:15 AM

DMSO PANEL
"The Challenge of Using M&S in T&E"
Panel Chair: *COL Jerry Glasow, USA, Director, DMSO*
Panelists:
Mr. Michael Crisp, ODOT&E
Mr. Chris Poust, TRMC, OSD
TBD, ATEC
Mr. Jerry Kitchen, AFOTEC
Mr. Steven Whitehead, OPTEVFOR

9:45 AM Break in Display Area

Session #5
MILITARY SERVICE PERSPECTIVES
Host: Dr. Ernest Seglie, DOT&E

10:15 AM	"Perspective from the Army," *Mr. Walter Hollis, DUSA/OR*
10:45 AM	"Perspective from the Navy," *RADM Bill McCarthy, USN, COMOPTEVFOR*
11:15 AM	"Perspective from the Air Force," *Mr. Jack Manclark, AF/Test & Evaluation Directorate*

11:45 AM

Annual Awards Luncheon
The Tester of the Year Awards are presented annually to civilian and military personnel supporting all of the military services and OSD. For each military service and OSD, an award is presented to the outstanding defense civilian, outstanding military, and outstanding supporting contractor.

Award Winners

Military	Civilian	Contractors
MAJ Sandy Vann, USA	Mr. Mark Simon, Army Civilian	Mr. Freddie Lee, Army Contractor
MAJ Victoria Miralda, USA, OSD	Mr. Tracy Sheppard, OSD Civilian	Mr. Steven Seiden, OSD Contractor
Maj James Colebank, USAF	Mr. Kenneth Lawrence, USAF Civilian	Ms. Katherine Hallett, USAF Contractor
CDR Chris Holmes, USN	Mr. Dean Kimelheim, Navy Civilian	Mr. Rollin Sublett, Navy Contractor
LtCol Christopher Seymour, USMC	Mr. Bruce Leaman, Marine Corps Civilian	Mr. Gary Evans, Marine Corps Contractor

Session #6
M&S STUDIES IN THE CONTEXT OF T&E AND ACQUISITION
Host: Dr. Lowell Tonnessen, IDA

1:15 PM	"Diagnosis of the Problem: What Prior Studies Have to Say," *Dr. James E. Coolahan, APL, JHU*
1:45 PM	"The Joint M&S Study", Dr. Frank Gray, *AFOTEC*
2:15 PM	"Open Air Testing vs. Modeling and Simulation: At Last Peaceful Coexistence?," *RADM Charles "Bert" Johnston, USN (Ret), Vice President & General Manager, Wyle Laboratories*
2:45 PM	Break in Display Area

Session #7
Host: Mr. John Illgen, Northrop Grumman

3:15 PM	"NDIA Industry Perspectives," *Lt Gen Larry Farrell Jr., USAF (Ret), President & CEO, NDIA*
3:45 PM	"Open Technology Development & Testing," *Mr. John Scott, Selection Pressure, LLC*
4:15 PM	"Modeling and Simulation of Systems," *Mr. Vincent M. Ortiz, AVW Technologies*
4:45 PM	"M&S / T&E Event – Working Together: AUV Fest 2005 ISR Scenario," *Mr. Reid Johnson, NUWC, Keyport*
5:15 PM	Afternoon Session Closes
6:00 PM - 9:00 PM	Paddle Boat Reception You are invited to join us for a reception wtih cocktails, heavy hors d'oeuvres, and a carving station aboard the *Lady St. Johns* hosted by NDIA and AVW Technologies. Only $25 per person. Guests are welcome to attend. Boarding time 6:00 PM - 6:30 PM at the Hyatt Regency Jacksonville dock located behind the hotel.

THURSDAY, MARCH 9, 2006

7:00 AM — Registration Opens

7:00 AM — Continental Breakfast in Display Area

8:00 AM — Call to Order and Administrative Announcements, *Mr. Sam Campagna, NDIA*

Session #8
Host: Dr. Paul H. Deitz, ARL

8:05 AM — "Using the Missions and Means Framework to Generate Cost- Effective Live-Fire Test and Evaluation Strategies"
Presenters:
Dr. Martha K. Nelson, Franklin & Marshall College & Dennis C. Bely, US Army Research Laboratory

9:00 AM — "Modeling and Simulation to Advance Test and Evaluation," *Dr. Sheldon Tieszen & Dr. Lou Gritzo, Sandia National Laboratories*

10:00 AM — Break in Display Area

10:45 AM — Begin Parallel Tracks

TRACK I	**T&E / M&S Architecture**	
	10:45 AM	11:15 AM
	"Test and Training Architecture, TENA, Offers Range Interoperability and Resource Reuse Solutions for DoD Test and Training Ranges," *Mr. Gene Hudgins, BAE Systems*	"LPD 17 PRA Testbed: A Case Study of T&E Data Supporting Architecture," *Mr. Vincent M. Ortiz, AVW Technologies*

TRACK II	**(VVA) "V,V&A" Issues to Make T&E/M&S Work Effectively**	
	10:45 AM	11:15 AM
	"LPD PRA Testbed VV&A Database: A disciplined Approach for VV&A," *Mr. Vincent M. Ortiz, AVW Technologies*	"Modeling and Testing of Civilian GPS Systems and Potential Vulnerabilities," *2Lt Shawn Littleton, USAF, Holloman AFB*

12:00 PM — Lunch

THURSDAY, MARCH 9, 2006 (Continued)

1:00 PM — Parallel Tracks Continued

TRACK I	Policy Proposals		
	1:00 PM	1:30 PM	2:00 PM
	"27 Steps to Success: The DoD Acquisition M&S Master Plan," *Mr. Fred Myers, OUSD(AT&L)/DS/SE*	"No More Second Opinions: Oganizing DoD M&S within the Acquisition Cycle, Mr. James O'Bryon, The O'Bryon Group	"Optimizing Cost and Time Effectiveness of Test and Evaluation Using Knowledge-Based Simulations," *Dr. Keith Bradley, LLNL*

TRACK II	Examples of Attempts to Get Mutual Support between T&E and M&S			
	1:00 PM	*1:20 PM*	*1:40 PM*	*2:00 PM*
	"Intelligent Munitions System: Balancing T&E and M&S," *Mr. William J. Bush, ARDEC, Picatinny Arsenal*	"Integration of Transport Modeling with Test and Valuation in CBR Building Protection Systems," *Mr. James Risser, Battelle*	"InterTEC: Testing Joint Mission Threats in a TENA Based Environment," *Mr. Robert Heilman, Pt. Mugu, CA*	"Dual Thrust Modified Smokey SAMS For Low Cost Testing and Simulation of Aircraft Missile Warning and Laser IRCM Systems," *Mr. William R. Taylor, (WPAFB)*

2:30 PM — Break in Display Area

Session #9
T&E / M&S Infrastructure Issues
Mr. Jim O'Bryon, NDIA T&E Division Chair, The O'Bryon Group

3:00 PM — General Session

"CAW (Center for Asymmetric Warfare) Use of M&S in Maritime HLS/HLD/ATFP Test and Training Exercises," Mr. *Arman Tchoubineh, NAWC WD, Pt. Mugu, CA*

"Knowledge is Power – Joint Datalink Information Combat Execution (JDICE) Joint Test and Evaluation," *Mr. Clarence Stone, JDICE JT&E OSD*

"Building An Extensable Virtual Sensor Network," *Mr. Joshua J. Pressnell, RTI*

"Commercial Air Services; Live Test Assets for Electronic Warfare," *Mr. Stan Ulkoski, PMA-207D2 Aircraft Operation Manager J.F.Taylor, Inc., NAVAIR support contractor; Ms. Linda Barrett (JFTI)*

5:00 PM — Conference Synopsis and Closing Remarks, *Mr. James O'Bryon*

(Reminder: Please submit your completed Conference Survey Sheets)

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AVW TECHNOLOGIES

22nd Annual National Test & Evaluation Conference
"Improving the Test and Evaluation of Defense and Homeland Security Systems Through Effective Development and Intelligent Application of Modeling and Simulation."
March 6-9, 2006

Optimizing Cost & Time Effectiveness of Test & Evaluation Using Knowledge-Based Simulations

- Click to e

Dr. Keith S. Bradley
Lawrence Livermore National Laboratory

March 9, 2006

This work was performed under the auspices of the U.S. Department of Energy by the University of California Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.

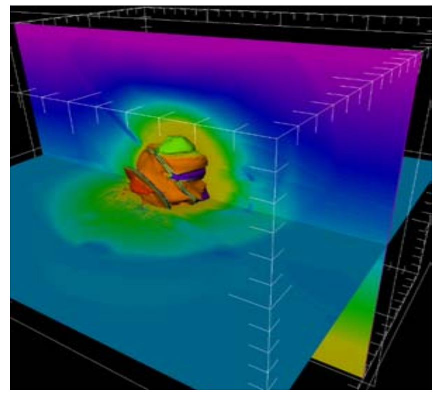
Modeling & Simulation will never *replace* Test & Evaluation

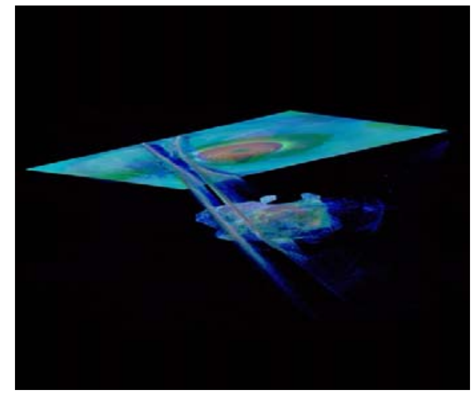
- There is no substitute for experience
- Even the most accurate simulations require understanding that is either obtained or validated by experiment
- Simulations that are not validated (VV&A) are about as useful as testing and evaluation techniques that are not validated

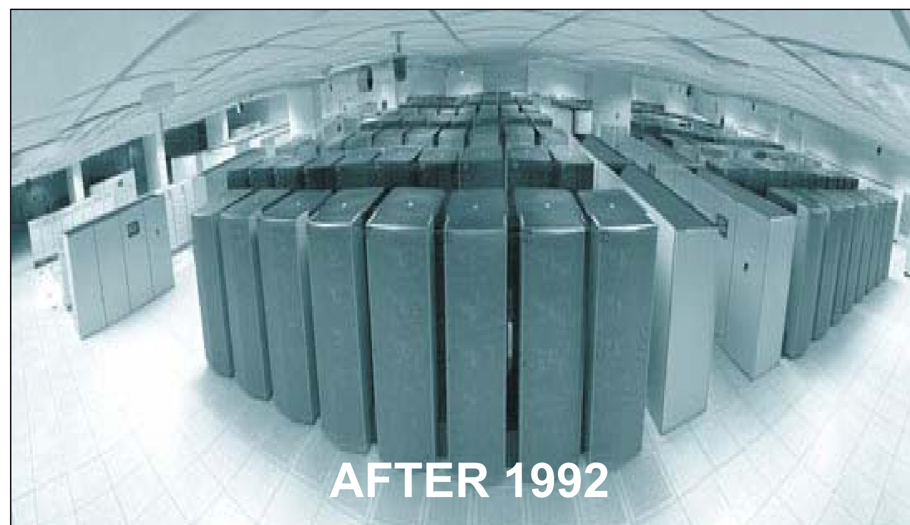
Intelligently applied, knowledge-based simulations can enhance the development and acquisition process

In 1992, the Department of Energy faced a perplexing new challenge

- **PRESIDENTIAL DIRECTIVE: Certify the performance, safety and reliability of the enduring nuclear deterrent WITHOUT TESTING.**







What are knowledge-based simulations?

Empirical Simulations	Knowledge-Based Simulations
• *Describe* outcomes – Use fits or tables derived from data – For quick interpolations between data points when variances are intuitive	• *Predict* outcomes – Use equations derived from understanding of governing mechanisms – For reasonable excursions beyond and between data points when variances aren't intuitive

Knowledge-based simulations can enhance test & evaluation in different ways

Design Tests

Where to "look"
What to "look for"
What to vary
Reduce risk for failure

Interpret Tests

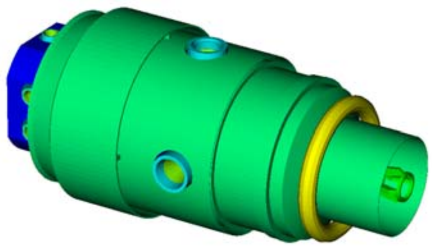
Unravel confusing data sets and provide insight about the important phenomena that produce them

Supplement Tests

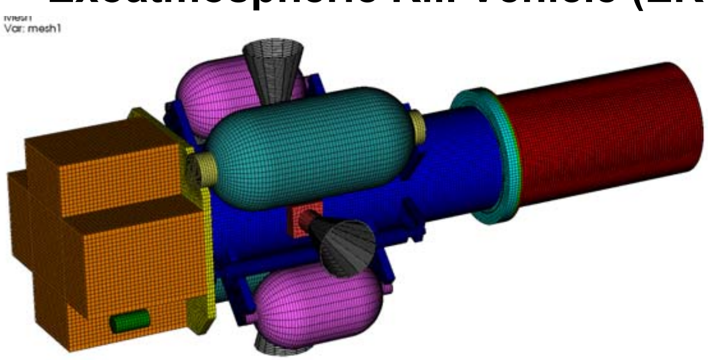
Provide insight where experiments are prohibitively expensive or physically impossible

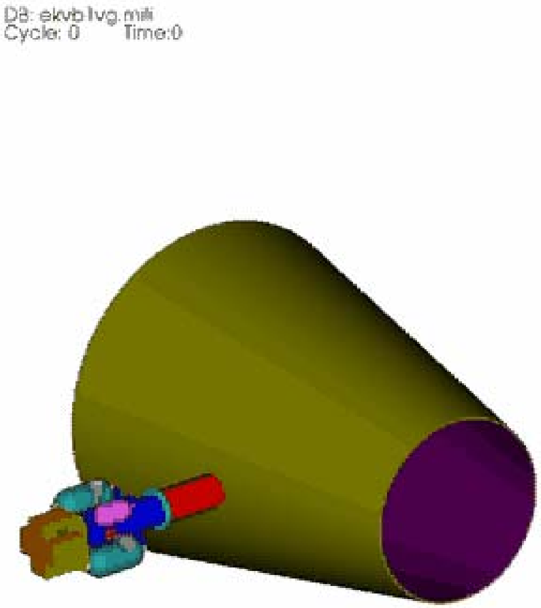
The missile defense community uses knowledge-based simulations to assess kinetic intercept lethality

Standard Missile -3 (SM-3, AEGIS)



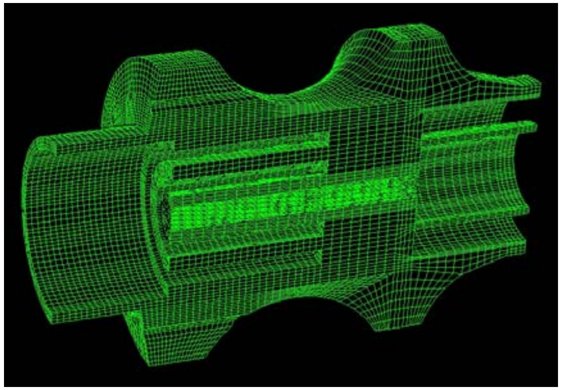
Exoatmospheric Kill Vehicle (EKV, GMD)

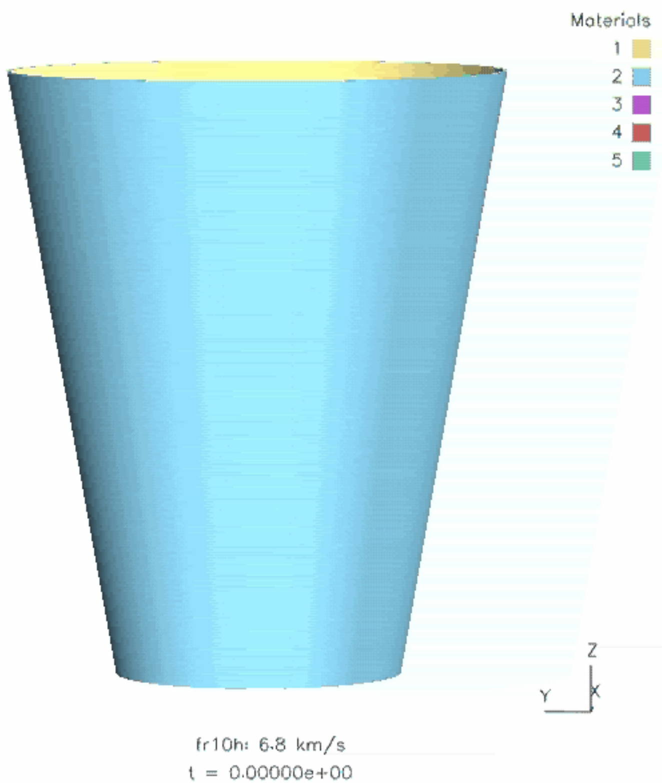


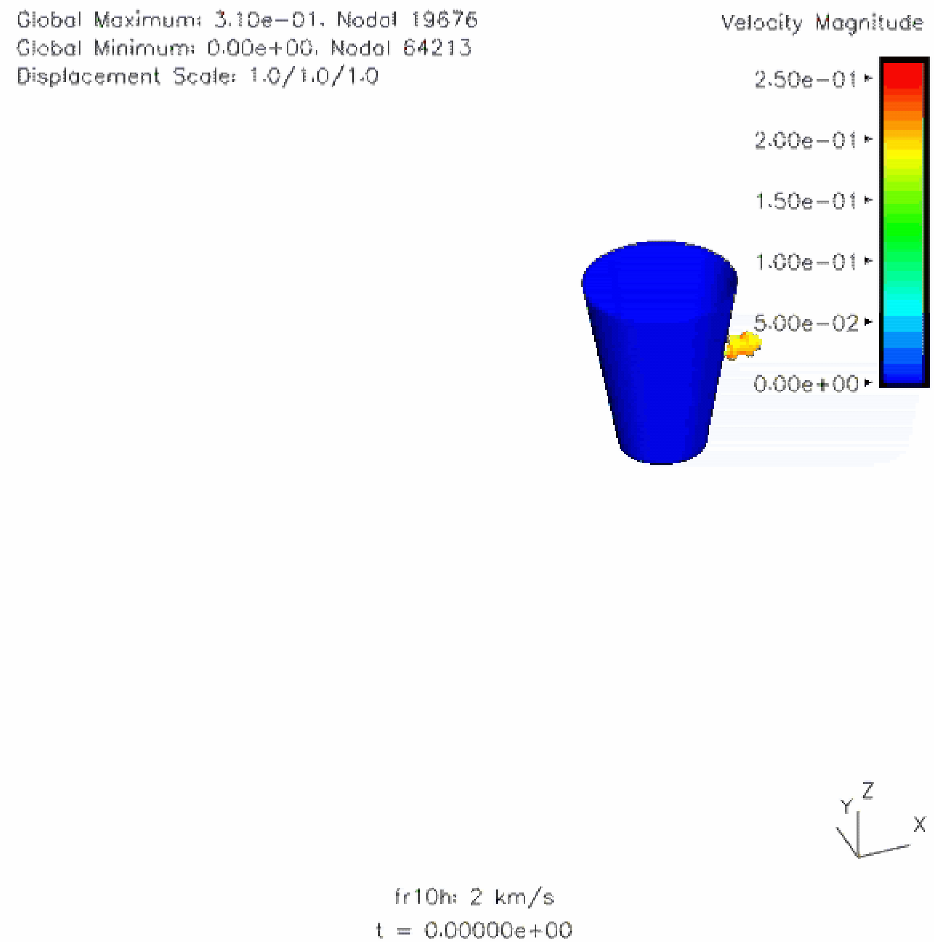


Simulated Ground-Based Midcourse Defense (GMD) Intercept

Debris patterns can be correlated with real-time hit assessment immediately following a flight test







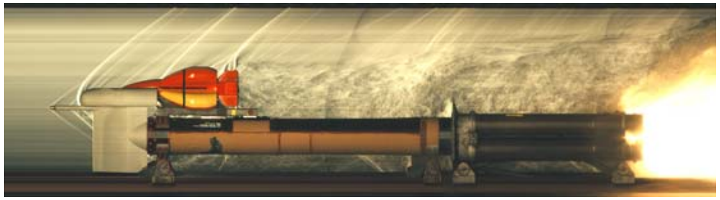
Missile intercept simulations contribute in all three categories

Design of Experiments

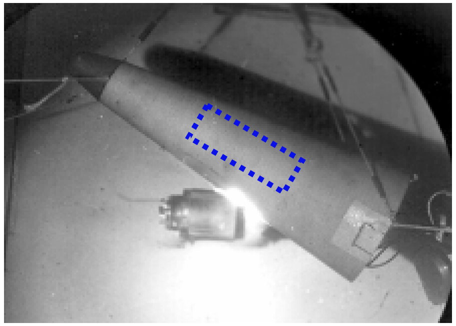
Interpretation of Experiments

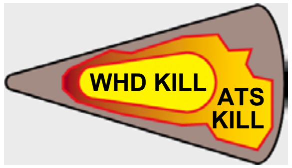
Supplement Experiments

Full-Scale Sled Track Test



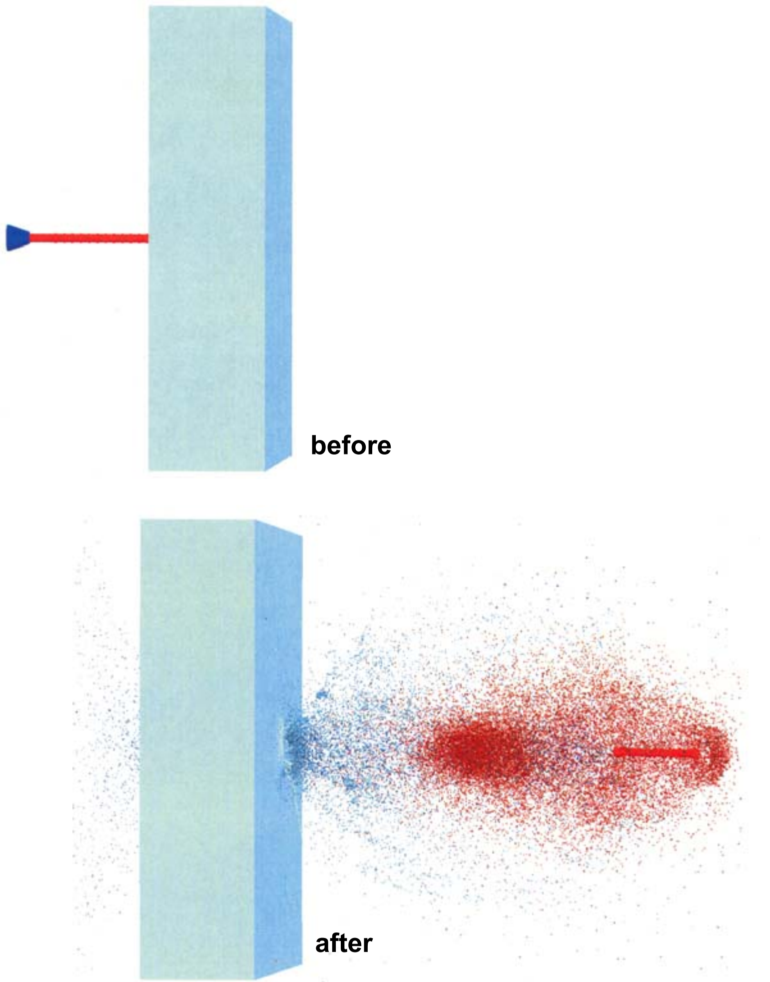
Scaled Light Gas Gun Test



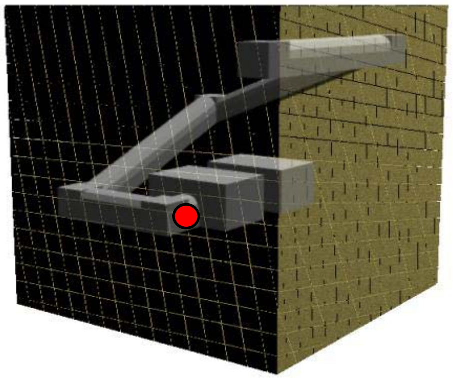


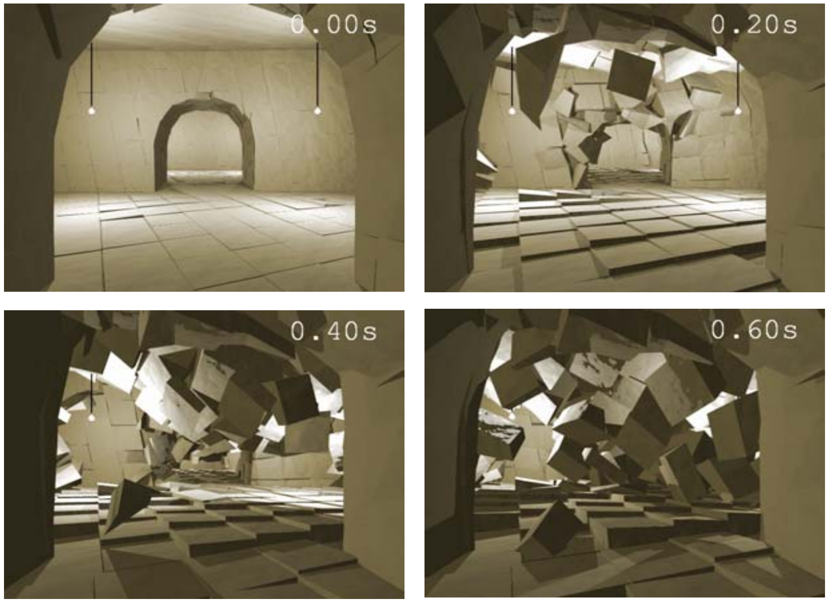
Penetration continues to be an important mechanism in weapon lethality

Penetration of Armor

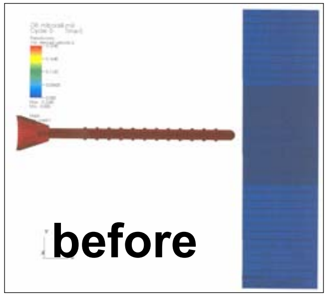


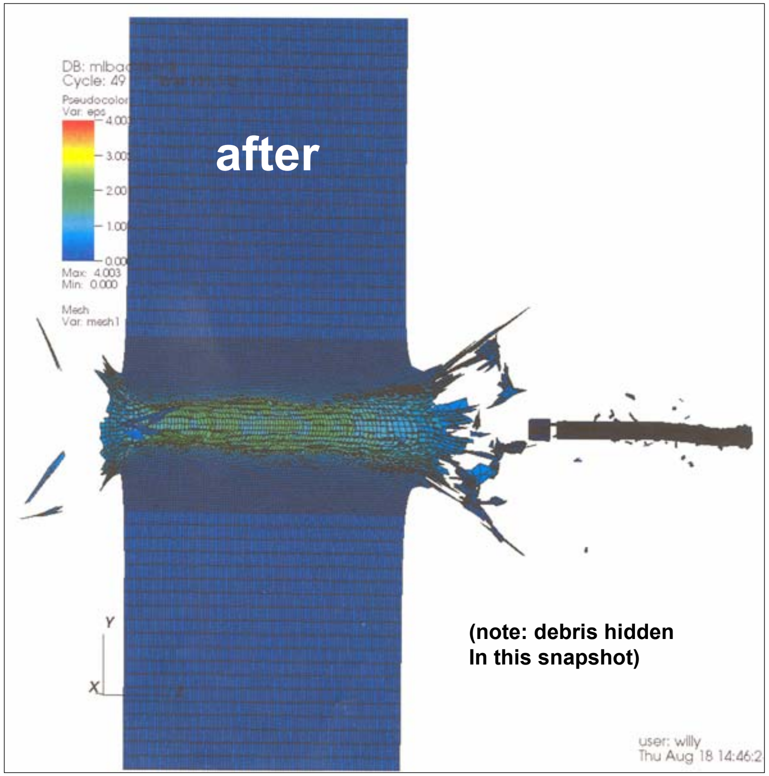
Defeat of Hard & Deeply Buried Targets

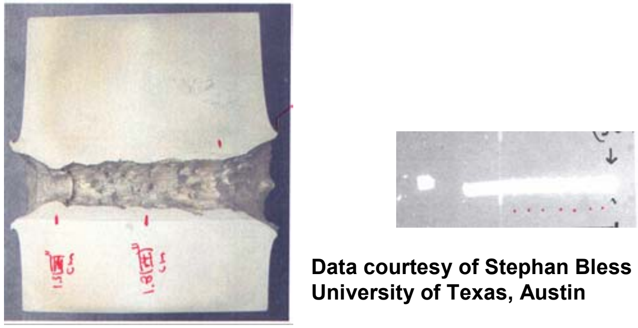




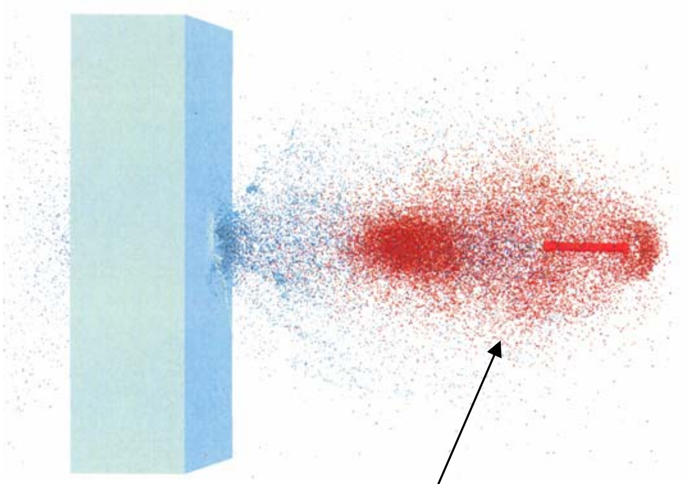
Predicting lethality requires predicting debris





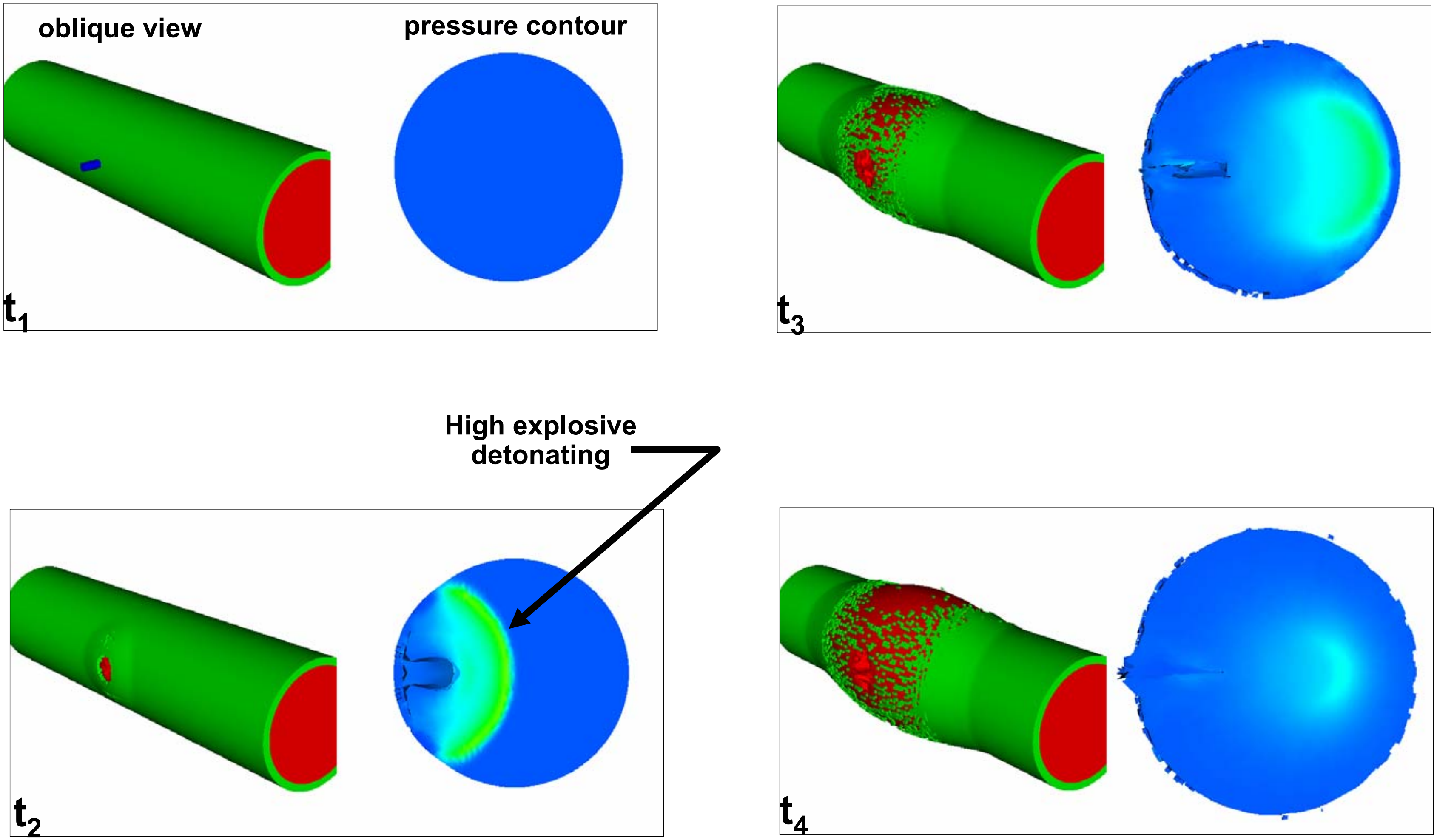


Data courtesy of Stephan Bless
University of Texas, Austin



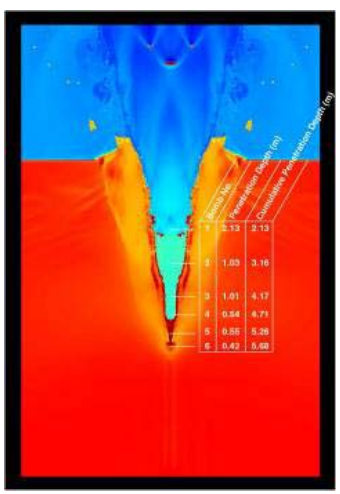
This debris is
usually what kills

Generating and propagating fragments is necessary to assess collateral effects

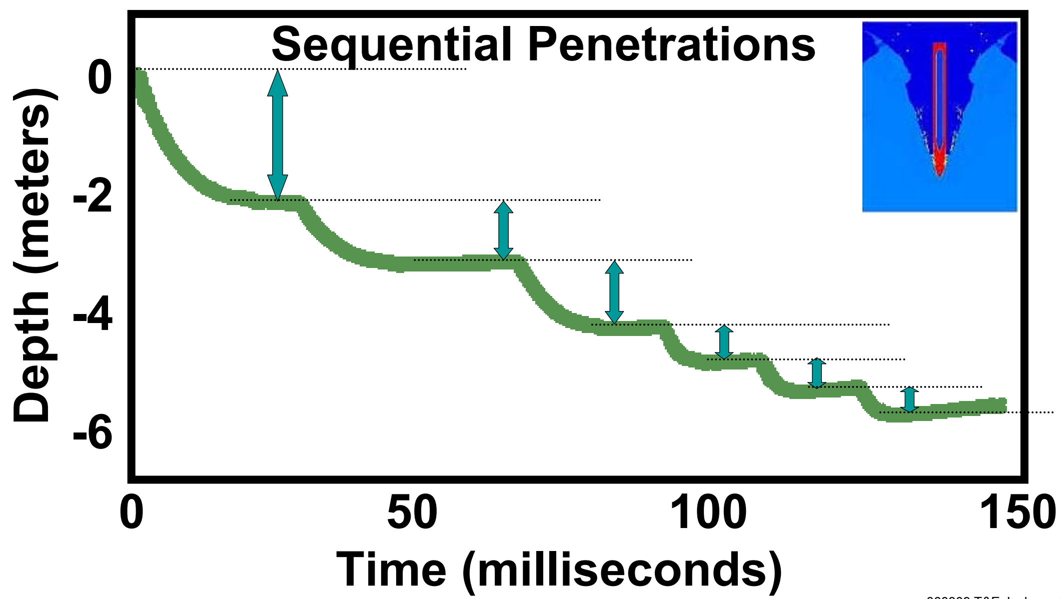


Ground shock (lethality) is significantly enhanced in a buried detonation

–BLU 116 Advanced Unitary Penetrator
- –Length: 2.4 m
- –Diameter: 25.4 cm
- –Thickness: 50 mm
- –Weight: 770 kg
- –HE weight: 65 kg

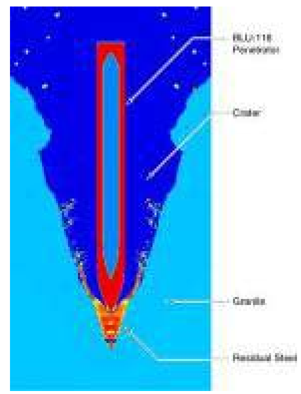


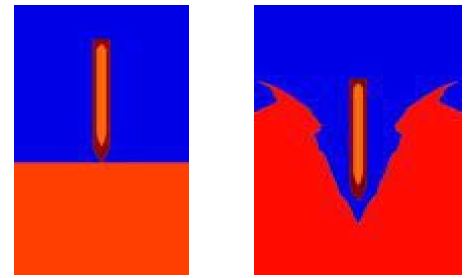
- Consider the scenario of sequentially delivered penetrators
- Penetration is less effective with successive attempts
- Can this process be optimized?



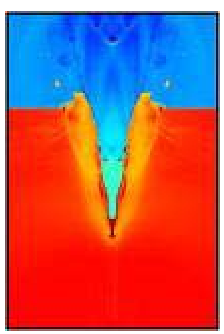
Insight gained from knowledge-based simulations suggests a modified approach

"Clearing" bomb debris from the crater led to a factor of **1.5** increase in penetration





Penetration at the surface is **4** times deeper than penetration inside a crater.



Penetration depth in shock-conditioned granite was **3** times greater than it was in virgin rock

Alternating penetrators with conventional bombs may be more effective

Knowledge-based simulations provide true value for defense acquisition

- Though M&S cannot replace T&E, they provide enhancements by
    - Optimizing the design of developmental and operational tests
    - Provide guidance in interpreting the results
    - Augment data sets when a test-only approach is cost-prohibitive, time-prohibitive or physically impossible
- These enhancements permit an additional means for exploring alternatives, modifications and “what if’s”
- Intelligently applied, knowledge-based simulations can accelerate discoveries and minimize risks in the development process

The 22nd Annual National Test & Evaluation Forum

Sponsored by the National Defense Industrial Association Test & Evaluation Division

March 7, 2006

Modeling the FCS Brigade Combat Team in a Stability and Reconstruction Operations Mission – Implications for T&E Planning

Held at The Hyatt Regency Jacksonville, Jacksonville, FL, 6-9 March, 2006.

LTC (R) Britt E. Bray
Dynamics Research Corp.
bbray@drc.com

Agenda: Tuesday, 7 March, 2006
Modeling the FCS Brigade Combat Team in a Stability and Reconstruction Operations Mission – Implications for T&E Planning

- Premise
- Background
- Applying the Framework to Generate Questions
- Notional Scenario Description and Mission Statement
- Front End Planning Products
- Implications for T&E Planning
- S&RO Challenges for T&E
- Summary and Conclusion

Premise

- Recent experience shows dramatic need for Army organizations to provide capability to succeed in Phase IV, Stability and Reconstruction Operations.
- Planning for T&E of FCS BCT should ensure Effectiveness, Suitability and Survivability of FCS BCT and its components conducting S&RO missions under realistic and relevant scenario driven conditions.
- Application of MMF principles to front end T&E planning can help to ensure that the right questions are asked and answered in the design and execution of the T&E plan.

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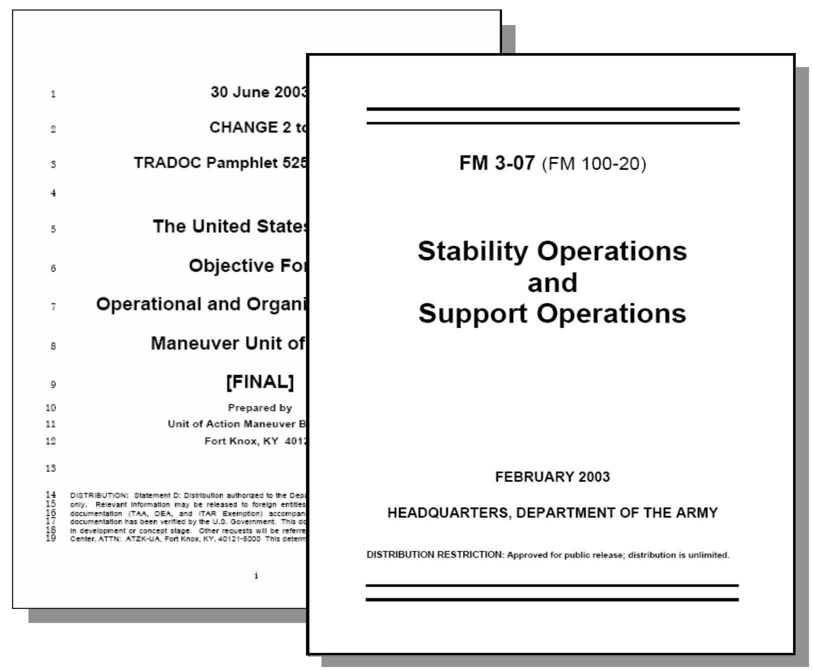
S&RO – A Quick Review

- **FM 3.07 provides Tier 1 doctrine for Stability and Support Operations**
- **FCS O&O identifies the following Stability, Support and Security Missions for the F-BCT:**
  - Peace Operations
  - Foreign Internal Defense
  - Security
  - Combating Terrorism
  - Arms Control
  - Show of Force
  - Area Security
  - Local Security



S&RO – A quick review

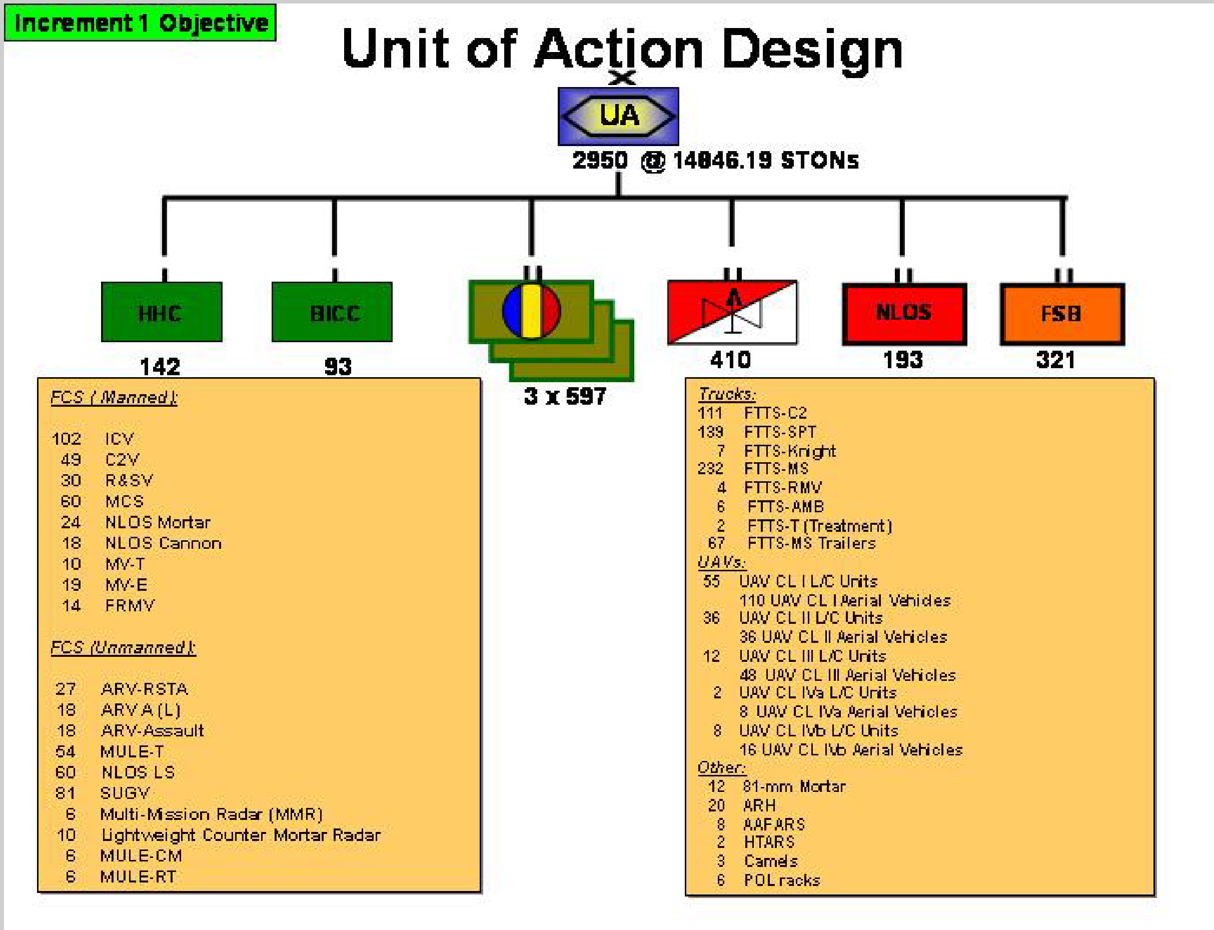
Potential S&RO Mission Types for F-BCT

- Secure a Route
- Conduct Airmobile Raid
- Secure a Site (FOB)
- Conduct Cordon and Search
- Escort a Convoy
- Execute a TCP
- Recon MSR
- Border Surveillance

FCS BCT O&O Overview

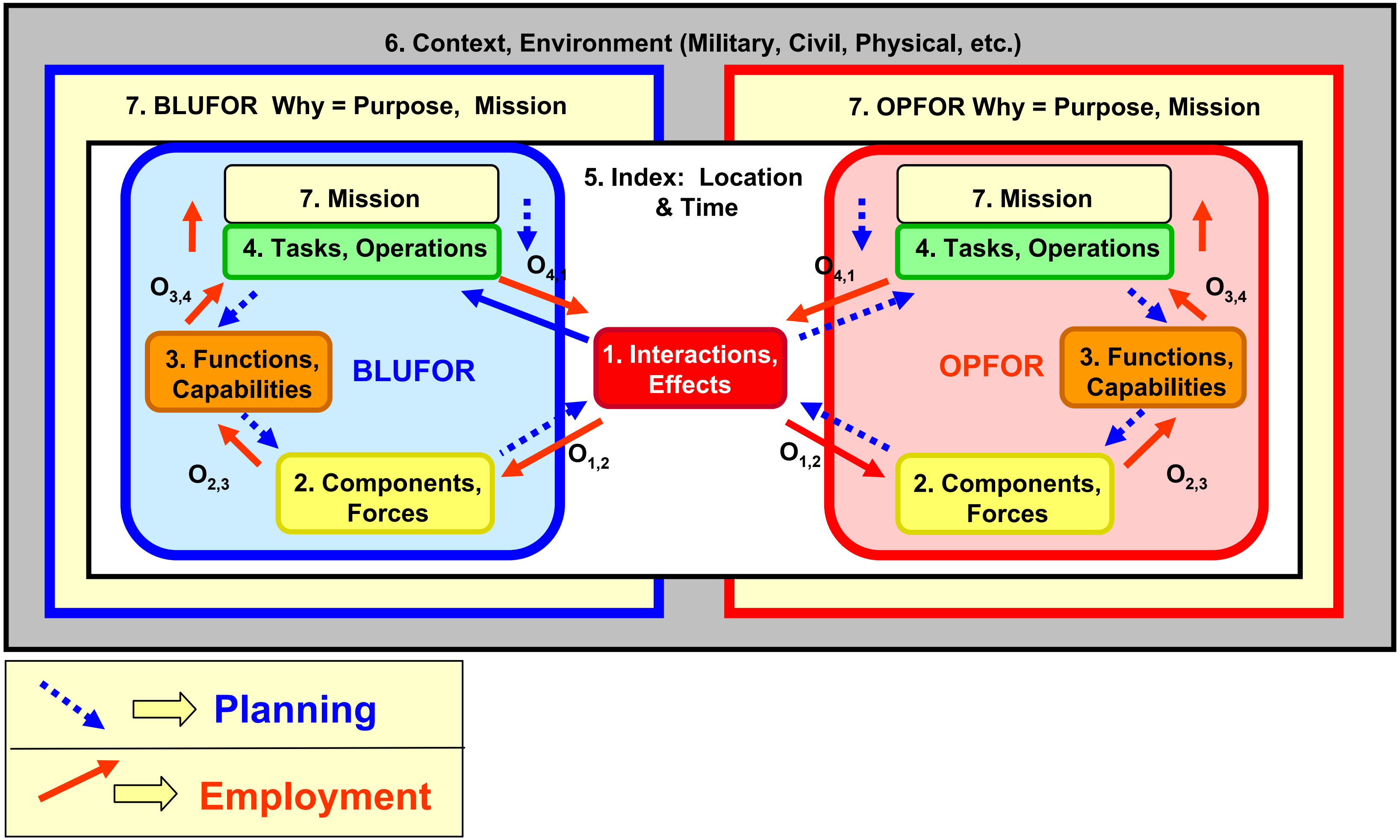
- **Qualities/Overarching Capabilities**
  - Quality of Firsts
  - Modes of Operation
  - Air Ground Integration
  - Ground Manned and Unmanned teaming
  - Lethal and Nonlethal Effects
  - Networked Fires
  - Maneuver Support Imperatives
  - Maneuver Sustainment in S&RO environment

FCS BCT Organization



MMF – A quick review

11 Fundamental Elements: 7 levels, 4 operators



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Applying the Framework to generate questions about the Mission …

Framework Level	Level Description in Terms of Military Operations	Questions related to Test and Evaluation
Level 7: Mission, Purpose	What is the Mission Task, Purpose, and Endstate for Friendly and threat forces?	What is the Mission Task, Purpose, and Endstate for friendly and threat forces? What operational scenario is to be used for the test?
Level 6: Context, Environment	What are the conditions under which the mission is to be performed?	What are the environmental factors that will impact on the mission? How do we replicate the appropriate environmental factors?
Level 5: Index, Location/Time	When, in terms of current or future time period and where, in terms of geographic location does the mission occur?	When and where is the mission to take place? What events (Road to War) led to this point? When and where will the test activities take place?

And the Means that lead to…

Framework Level	Level Description in Terms of Military Operations	Questions related to Test and Evaluation
Level 4: Tasks, Operations	What operations and tasks must be performed to accomplish the mission	What types of operations and what tasks must the organization under test perform in order to accomplish the mission? What is purpose for each operation and task? What are the associated MOEs and MOPs? What conditions are in place that could affect task performance?
Level 3: Functions, Capabilities	What functions and capabilities are required to enable successful accomplishment of task purpose?	What functions and capabilities and capabilities are required to enable successful performance of the operations and tasks under identified conditions?
Level 2: Components, Forces	What equipment, personnel and forces are available to provide required functions and capabilities	What components and forces are available to perform the mission and what functions and capabilities do they provide?
Level 1: Interactions, Effects	What interactions must occur to create the desired effect.	What interactions/events must be stimulated/simulated?

T&E Planning and Coordination Questions

- Does a suitable scenario exist or will one have to be generated?
- What are the most important capabilities to test and evaluate? Under what conditions?
- What operations and tasks require the identified capabilities?
- What components and forces of the System under test deliver and/or employ the capabilities identified above?
- What kind of LVC environment is required to adequately support observation and evaluation of the identified components/forces performing the identified tasks?
- Do resources and facilities currently exist to provide the required LVC environment or will some have to be developed?

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Notional Scenario Situation

- FCS BCT Operating as part of Ground Component of a Joint Force conducting offensive operations in Orangeland.

- FCS BCT Operating as part of Ground Component of a Joint Force conducting offensive operations in Orangeland.

Notional Scenario Mission Statement

- FCS BCT Mission as a supporting effort is to occupy Objective Hula in order to secure the MSR running from north to south through the objective and initiate stabilization and reconstruction of the urban areas in Objective Hula.

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Notional Mission to Task Analysis

Mission: (U)Establish the Forward Operating Base (98 task(s))

FCS 17-6-C1001 Conduct Continuous Risk Management

FCS 17-6-C1202 Operate in a JIM Environment

FCS 17-6-S1003 Gain and maintain situational understanding (e.g., the COP) of the battle space as it applies to JIM elements

FCS 17-6-S1013 Employ Collaborative Networked Fires

FCS 17-6-S1204 Conduct a Tactical Road March

FCS 17-6-S1402 Employ Army and Joint ISR

FCS 17-6-S1406 Integrate Contract/Contractor Support Personnel Into UA Sustainment Operations

FCS 17-6-S2608 Transition to Changes in Focus and Mission in a JIM Environment

FCS 17-6-U1004 Facilitate Exchange of Information With JIM Units, Agencies and Representatives at Appropriate Level using WMI

FCS 17-6-U1005 Coordinate and Perform Intelligence, Surveillance and Reconnaissance (ISR) in a JIM environment

FCS 17-6-U1006 Coordinate and Maintain Relevant JIM War Fighter Networks (Warrior Machine Interface)

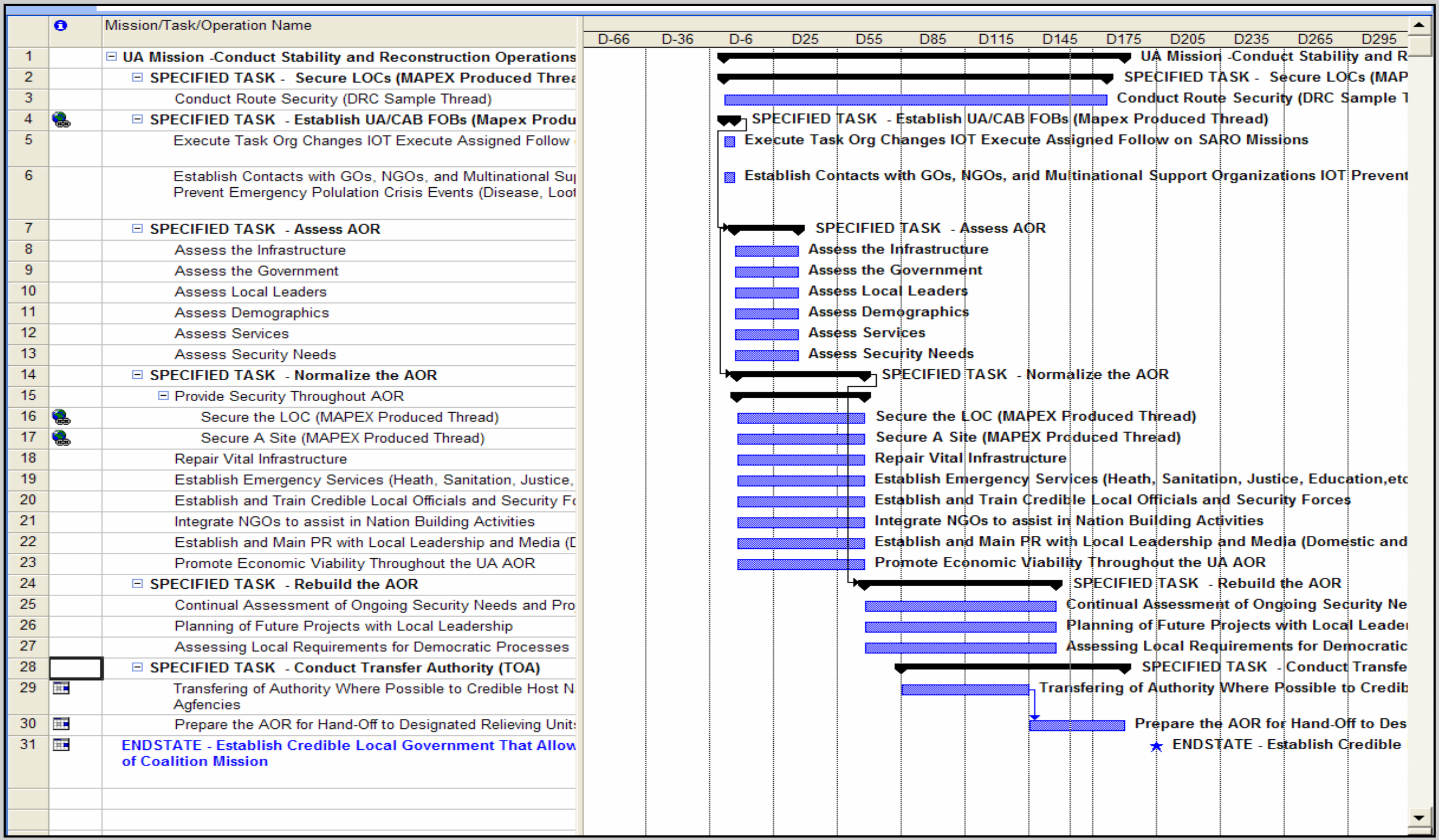
FCS 17-6-U1012 Participate in Joint and Multinational Air Space Management

FCS 20-2-S6203 Control Checkpoint (SOSO)

Notional FCS BCT Organization for Combat

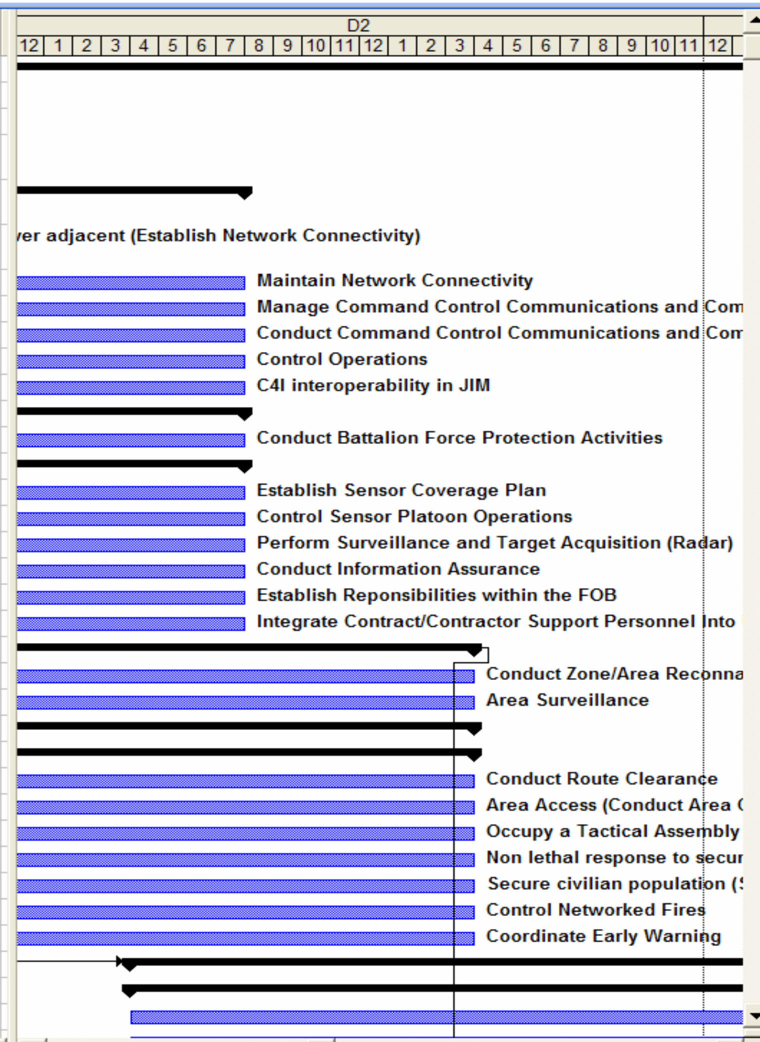
- HQ’s BCT (FOB A)
  - 3rd CAB
  - HHC BCT
  - BICC
  - NLOS BN (-)
  - FSB (-)
- Group Tiger (FOB B)
  - 1st CAB
  - 2nd CAB
  - Team C, NLOS BN
  - Team C, FSB
- RSTA SQDN (FOB C)

Sample Mission Thread(s) for selected vignettes



Sample Mission Thread(s) for selected vignettes

	Mission/Task/Operation Name	Task Ref #
1	⊟ **Establish the FOB**	**FCS 7-1-U4014**
2	⊟ **Select/Establish AORs**	**ART 7.1.1**
3	⊟ **Select FOB location**	**FCS 7-1-U4014**
4	⊞ **Gain and maintain situational understanding (e.g., the COP) of the battle space as it applies to JIM elements**	**FCS17-6-S1003**
17	⊟ **C2 the UA/CAB (Conduct Battle Command)**	**FCS 71-6-U2052**
18	Establish communications higher lower adjacent (Establish Network Connectivity)	FCS 71-5-U3118
19	Maintain Network Connectivity	FCS 71-5-U3119
20	Manage Command Control Communications and Computers (C4) Oper	FCS 71-6-S2303
21	Conduct Command Control Communications and Computer (C4) Opera	FCS 71-6-U2301
22	Control Operations	FCS 71-6-U2101
23	C4I interoperability in JIM	FCS17-6-U1006
24	⊟ **Maintain Force Protection (Coordinate Force Protection Activities)**	**FCS71-6-U2520**
25	Conduct Battalion Force Protection Activities	FCS 71-1-S2520
26	⊟ **Protect force from fires**	**FCS17-6-S2604**
27	Establish Sensor Coverage Plan	FCS 71-6-U2155
28	Control Sensor Platoon Operations	FCS6-3-U6017
29	Perform Surveillance and Target Acquisition (Radar)	FCS6-4-U6045
30	Conduct Information Assurance	FCS 71-5-U3124
31	Establish Reponsibilities within the FOB	ART 7.5.3
32	**Integrate Contract/Contractor Support Personnel Into UA Sustainmei**	FCS17-6-S1406
33	⊟ **Secure FOB locations (Conduct Rear Area and Base Security Operat**	**ART 5.3.5.4.1**
34	Conduct Zone/Area Reconnaissance	FCS 7-2-S4404
35	Area Surveillance	FCS17-2-U4011
36	⊟ **Assured Mobility (Coordinate Assured Mobility Operations)**	**FCS 71-6-U2525**
37	⊟ **Clear Obstacles**	**ART 5.1.1.2**
38	Conduct Route Clearance	ART 5.1.1.2.2
39	Area Access (Conduct Area Clearance)	ART 5.1.1.2.1
40	Occupy a Tactical Assembly Area	FCS 7-1-S4200
41	Non lethal response to security threats (Engage and Control Civilian Pc	FCS 7-2-S4205
42	Secure civilian population (Secure Civilians during Operations (SOSO))	FCS 20-3-S6214
43	Control Networked Fires	FCS 71-6-U2360
44	Coordinate Early Warning	FCS 71-6-U2366
45	⊟ **Defend the FOB**	**FCS7-2-S4010**
46	⊟ **Entry/Exit Control**	**NA**
47	Plan ECPs and Provide Resources	NA



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Implications for T&E planning

- **Need to develop cross-walk of capabilities to tasks to sharpen focus of observation/data collection plan.**
- **Need to develop cross-walk of selected tasks to executors of tasks.**
- **Need to determine interactions needed to trigger execution of tasks.**
- **Need to maintain coherent mission thread for vignette being run in order to determine and trace mission impact of task success or failure (i.e. establish an audit trail).**
- **Need to determine minimum level of granularity required for meaningful execution (test) and evaluation.**
- **Need to structure test support plan to enable execution, observation and data collection of test events at the required level of granularity.**

S&RO challenges

- **How do you determine mission success?**
- **How do you determine and document the impact of a single task on the mission?**
- **What are the unique combinations of capabilities, tasks and F-BCT components that must be tested and evaluated to determine ESS of the F-BCT in performing S&RO versus other kinds of missions?**
- **How do you factor in augmentation from Echelons above F-BCT, Joint, Coalition and other capability providers to the T&E plan?**
- **How do you replicate the Operating Environment for the S&RO Scenario?**
  - **Examples of S&RO unique conditions**
    - **Forward Operating Base (FOB) based operations in or near urban built up areas**
    - **Joint, Interagency, Multinational (JIM) environment**
    - **Non-linear, Guerrilla-style threat**
    - **Fleeting indirect fire threat**
    - **Primarily small unit (platoon/company) size operations**

Summary and Conclusion

- S&RO missions pose unique and challenging issues to consider for T&E planning
- Application of MMF to front end analysis enhances ability to:
  - Understand all aspects of the problem space and their interrelationships
  - Bring together stakeholder communities early for productive and effective input, coordination and review.
  - Identify T&E capability gaps early.

Questions/Discussion?

The 22nd Annual National Test & Evaluation Forum

Sponsored by the National Defense Industrial Association Test & Evaluation Division

March 6, 2006

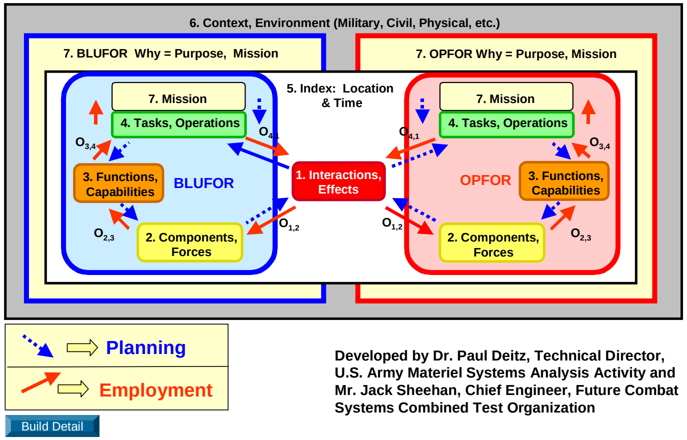
Tutorial
Putting the MMF to Work to Drive Analysis – Getting to the "So What" by Asking the Right Questions About the Mission

Held at The Hyatt Regency Jacksonville, Jacksonville, FL, 6-9 March, 2006.

Outline

Missions and Means Framework Model

11 Fundamental Elements: 7 levels, 4 operators



Developed by Dr. Paul Deitz, Technical Director, U.S. Army Materiel Systems Analysis Activity and Mr. Jack Sheehan, Chief Engineer, Future Combat Systems Combined Test Organization

- Introduction
- Background/MMF Review
- Using MMF to get to the "So What"
- Practical application – How MMF can be applied to ask the right questions and organize the resulting information.
- A few examples of MMF application to T&E
- Conclusion/Summary

Why Develop New Material Solutions?

A. Because We Can?

B. Advances in Technology?

C. To Accomplish Operational Missions Under Changed Operational Environment?

What's Changed?

A. Network-Enabled Capabilities

B. Joint Interdependence

C. Development and Fielding of Systems of Systems

Some Impacts on T&E

A. How do you Measure Contribution of Individual Parts to Effectiveness of the Whole?

B. How do you Measure Contribution of Combinations of Parts to Effectiveness of the Whole?

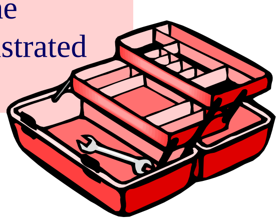
C. How do you Measure Contribution of Non-Lethal Capabilities to Mission Accomplishment/Effectiveness?

D. How do you Tie in Planning for and Results of Distributed Test Events to a Single Integrated T&E Plan?

E. How do you Measure Contribution of Human in the Loop and HSI to Mission Accomplishment/Effectiveness?

ATEC’s “mission-to-capability trace”

Mission-task decomposition provides the test planner with a powerful tool to design the best test plan possible. It stems from user validated scenarios, missions and tasks --providing the framework for evaluating demonstrated FCS system and SoS capabilities



Missions

to accomplish

comprise

Tasks

to perform

DOTLPF *

enabled by

Capabilities

provides

Answers the “So What?” Question

as supplied by

Materiel

* Doctrine, Organization, Training, *Materiel*, Leadership and Education, Personnel, Facilities

Missions & Means Framework (MMF)

- Purpose:
  - Methodology for explicitly specifying military mission
  - Quantitatively evaluate mission utility of alternative warfighting DOTMLPF* services/products

- Objective: Provide disciplined procedure to explicitly ***specify*** mission, ***allocate*** means and ***assess*** mission accomplishment by:
  - Unifying warfighter, engineer and comptroller understanding of missions and means
  - Accounting for traditional T&E factors and traditional warfighter expertise factors that constitute mission success
  - Being sufficiently credible, timely and affordable to make hard decisions that stay made
  - Being consistent, concise, repeatable and scalable
  - Providing disciplined process to implement SECDEF's transformation guidance and associated acquisition reform.

*DOTMLPF = Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel and Facilities

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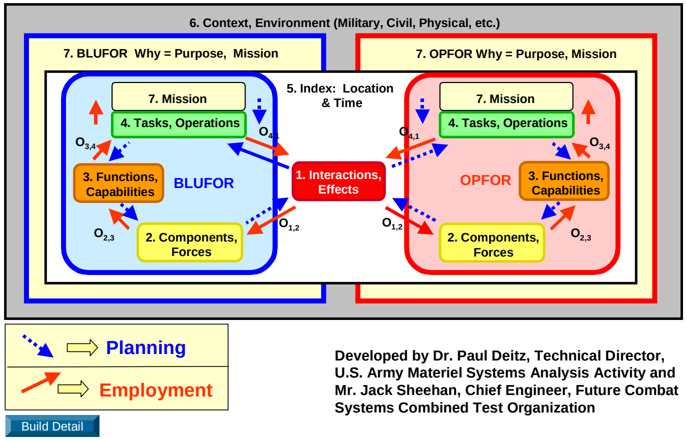
Missions and Means Framework Model

11 Fundamental Elements: 7 levels, 4 operators



Developed by Dr. Paul Deitz, Technical Director, U.S. Army Materiel Systems Analysis Activity and Mr. Jack Sheehan, Chief Engineer, Future Combat Systems Combined Test Organization

- Introduction
- Background/MMF Review
- Using MMF to get to the "So What"
- Practical application – How MMF can be applied to ask the right questions and organize the resulting information.
- A few examples of MMF application to T&E
- Conclusion/Summary

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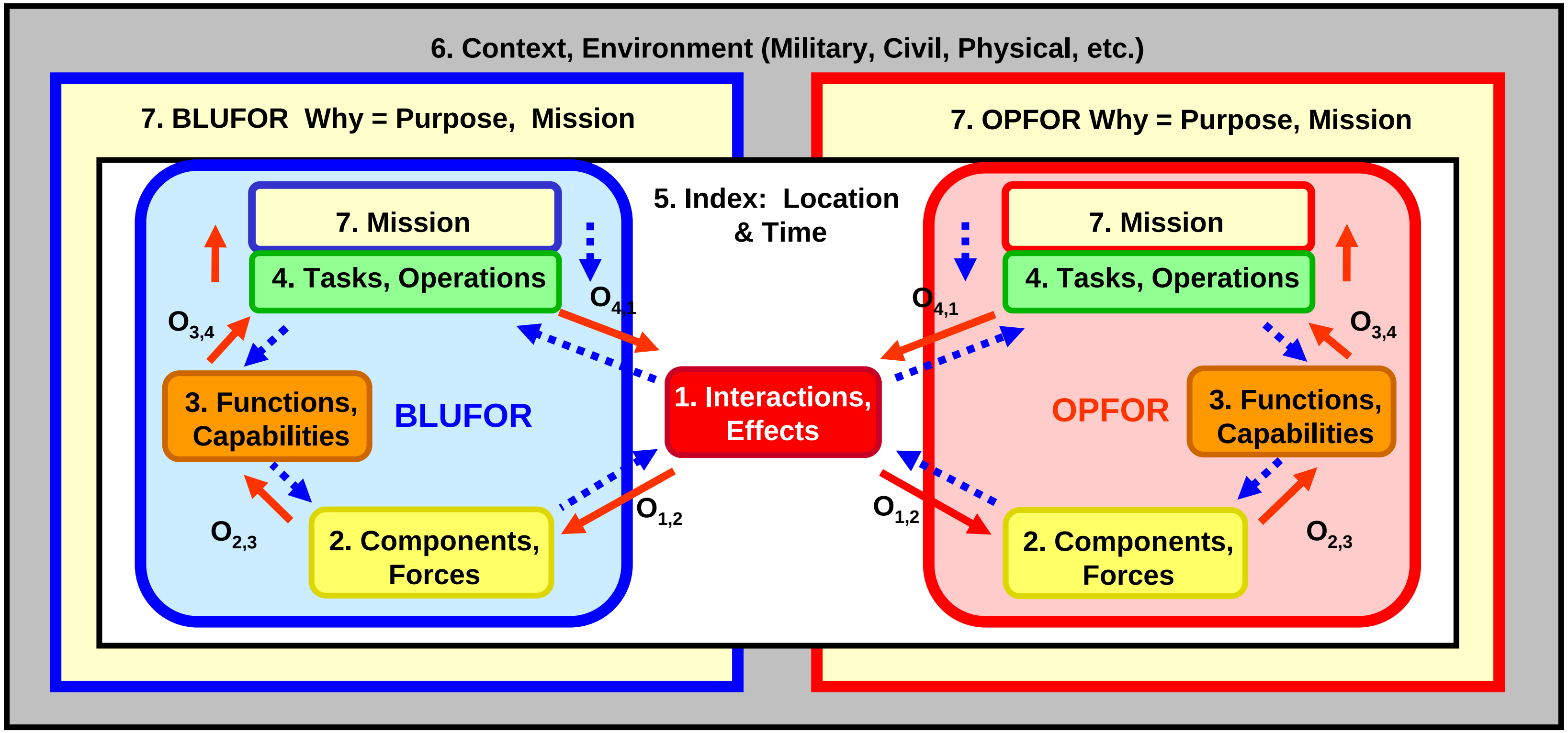

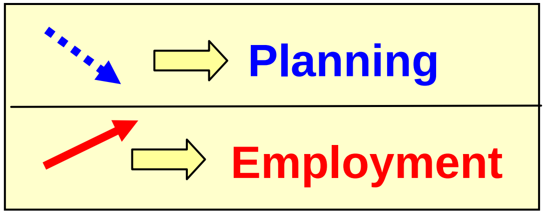

Build Detail

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Outline

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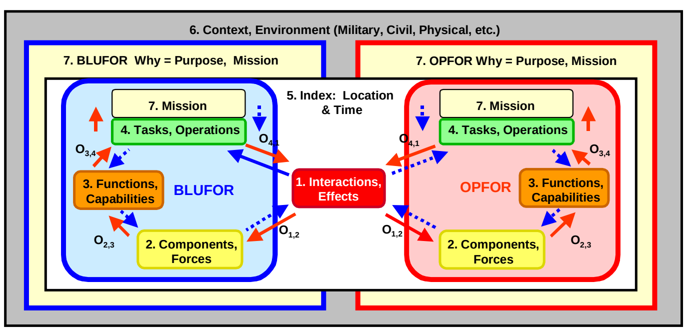

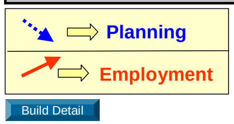

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Applying the Framework to generate questions about the Mission …

Framework Level	Level Description in Terms of Military Operations	Questions related to Test and Evaluation
Level 7: Mission, Purpose	What is the Mission Task, Purpose, and Endstate for Friendly and threat forces?	What is the Mission Task, Purpose, and Endstate for friendly and threat forces? What operational scenario is to be used for the test?
Level 6: Context, Environment	What are the conditions under which the mission is to be performed?	What are the environmental factors that will impact on the mission? How do we replicate the appropriate environmental factors?
Level 5: Index, Location/Time	When, in terms of current or future time period and where, in terms of geographic location does the mission occur?	When and where is the mission to take place? What events (Road to War) led to this point? When and where will the test activities take place?

And the Means that lead to…

Framework Level	Level Description in Terms of Military Operations	Questions related to Test and Evaluation
Level 4: Tasks, Operations	What operations and tasks must be performed to accomplish the mission	What types of operations and what tasks must the organization under test perform in order to accomplish the mission? What is purpose for each operation and task? What are the associated MOEs and MOPs? What conditions are in place that could affect task performance?
Level 3: Functions, Capabilities	What functions and capabilities are required to enable successful accomplishment of task purpose?	What functions and capabilities and capabilities are required to enable successful performance of the operations and tasks under identified conditions?
Level 2: Components, Forces	What equipment, personnel and forces are available to provide required functions and capabilities	What components and forces are available to perform the mission and what functions and capabilities do they provide?
Level 1: Interactions, Effects	What interactions must occur to create the desired effect.	What interactions/events must be stimulated/simulated?

T&E Mission Statement

Data Needed	Known Information	Unknown Information
Level 2: Force Listing/TOEL/TDA	**Level 2:** Components/Forces	**Level 5-7:** External operational mission
Level 3: Performance/Behavior Function/Capability Desc	**Level 3:** Functions/Capabilities to be delivered (based on O&O/ORD)	**Level 4:** Tasks/Operations
Level 4: Task Lists		**Level 3:** Functions/Capabilities required in this mission
Level 5-7: Opnl Scenario/vignettes		**Level 1:** Interactions/Desired Effects

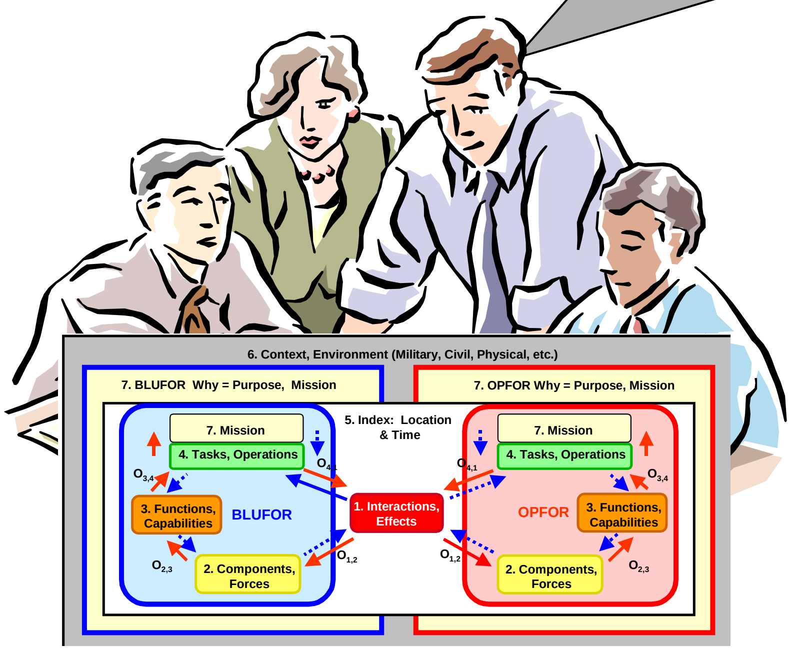
T&E Planning and Coordination Questions

- **Does a suitable scenario exist or will one have to be generated?**
- **What are the most important capabilities to test and evaluate? Under what conditions?**
- **What operations and tasks require the identified capabilities?**
- **What components and forces of the System under test deliver and/or employ the capabilities identified above?**
- **What kind of LVC environment is required to adequately support observation and evaluation of the identified components/forces performing the identified tasks?**
- **Do resources and facilities currently exist to provide the required LVC environment or will some have to be developed?**

Implications for T&E planning

- Need to develop cross-walk of capabilities to tasks to sharpen focus of observation/data collection plan.
- Need to develop cross-walk of selected tasks to executors of tasks.
- Need to determine interactions needed to trigger execution of tasks.
- Need to maintain coherent mission thread for vignette being run in order to determine and trace mission impact of task success or failure (i.e. establish an audit trail).
- Need to determine minimum level of granularity required for meaningful execution (test) and evaluation.
- Need to structure test support plan to enable execution, observation and data collection of test events at the required level of granularity.

So how do we make this work?



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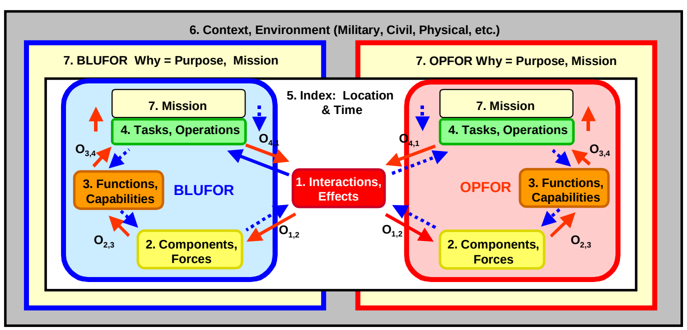

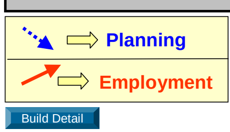

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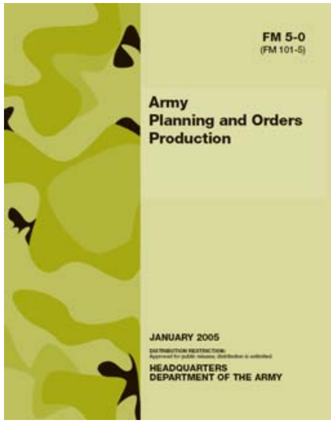
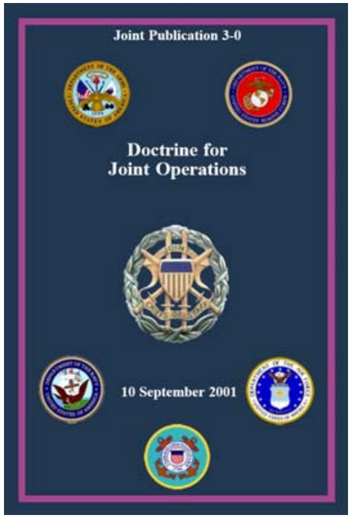
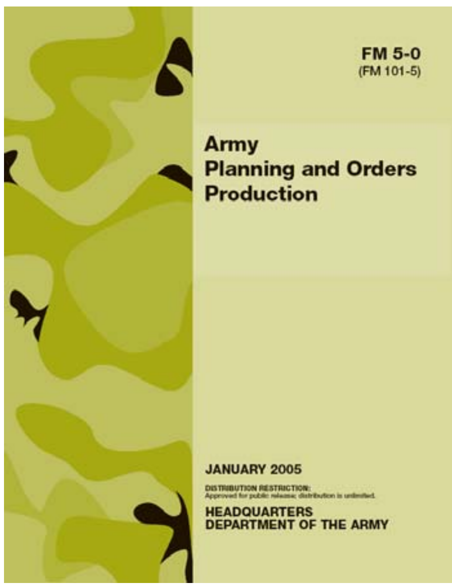
MMF Builds on Doctrinal Processes

- MDMP
  - Mission Analysis
  - COA Development
  - Wargaming
- Operations
- Training & Readiness
  - JTS Phases
  - JMETL/METL Development and Assessment





The MDMP – Its About the Mission



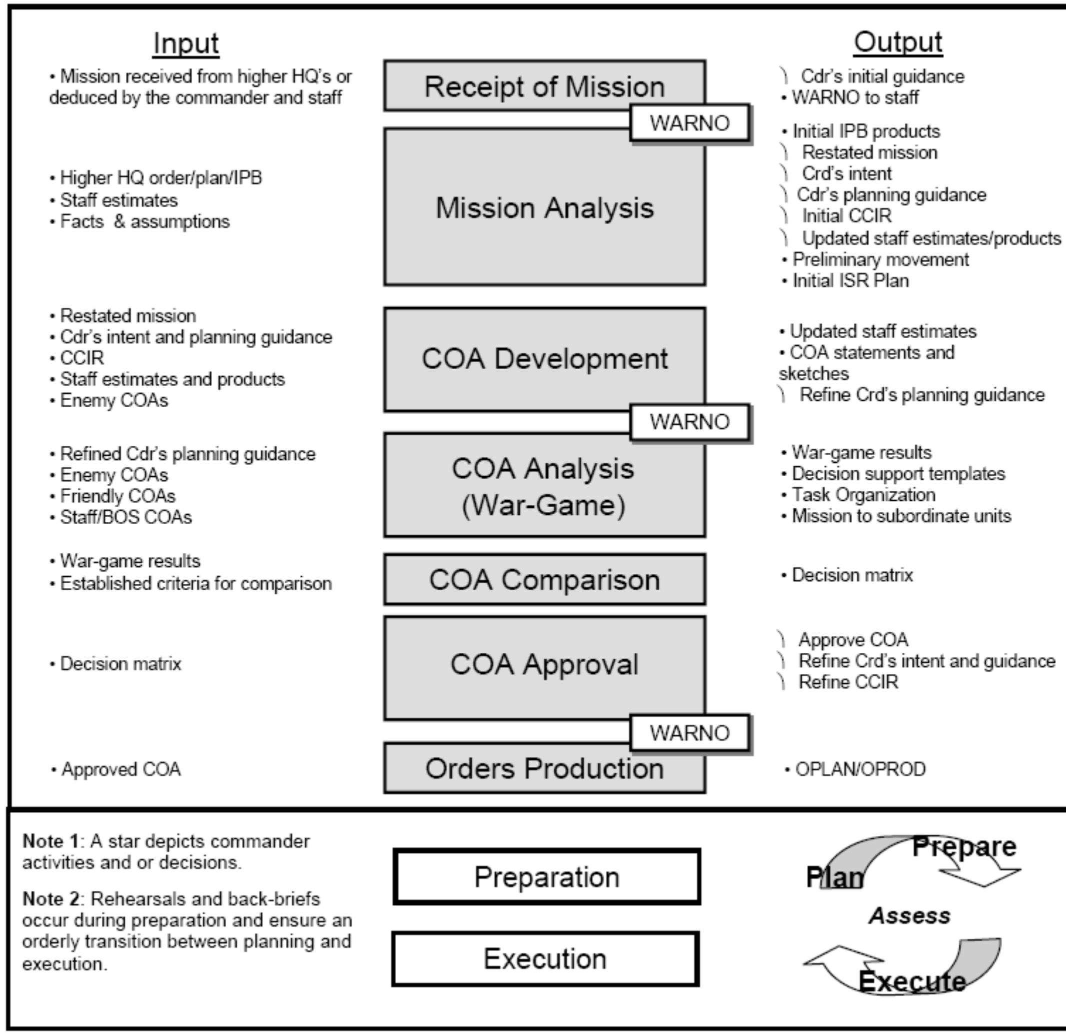
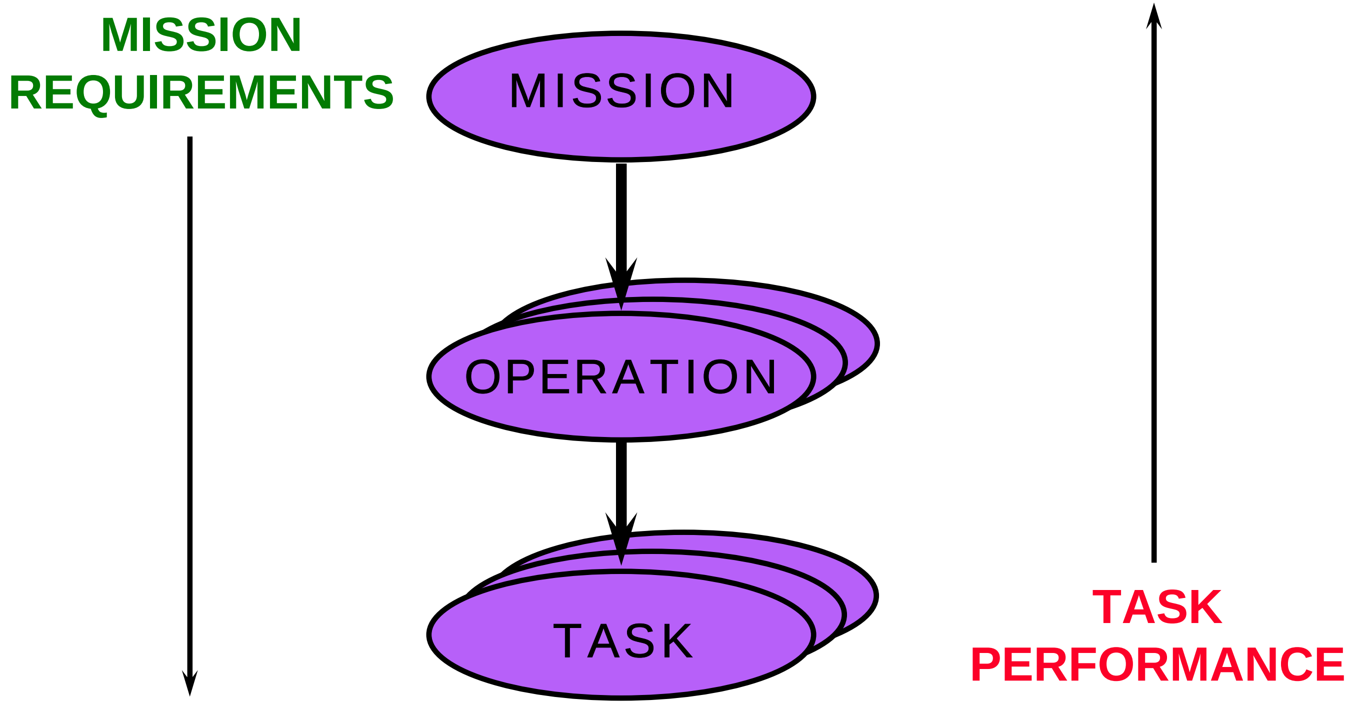


Figure 3-1. The Military Decision Making Process

Mission / Operation / Task



- We measure Task Performance
  - Task to Operation (Small to Big)
- We measure Mission Accomplishment
  - Are we getting the job done (MOEs)

Mission to Task Decomposition – Establishes Vertical Linkage…

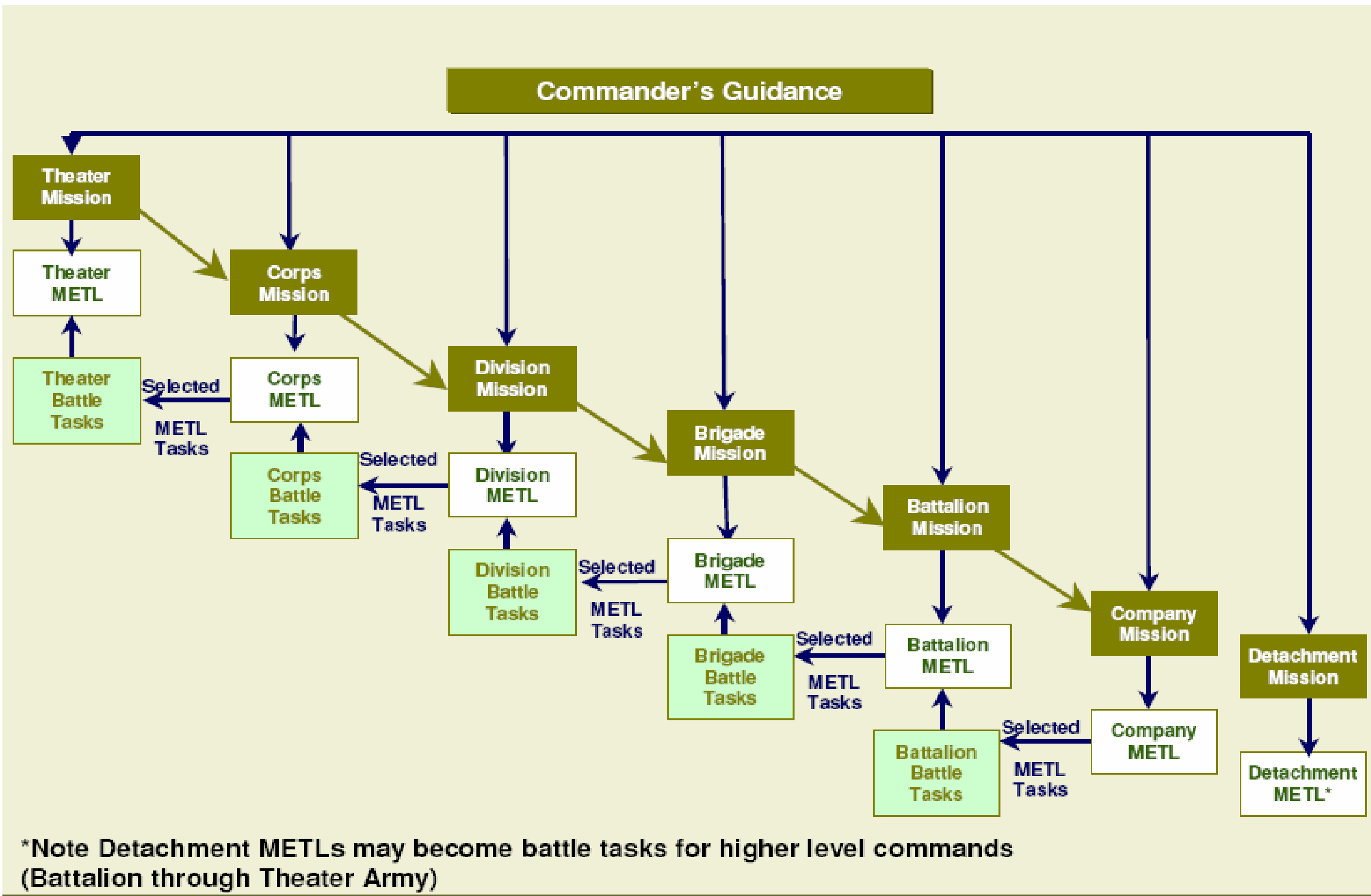


Figure 3-10. Relationships Between Mission, METL, and Battle Task

… and Horizontal Linkage between subordinate units…

Corps Mission Essential Task: Conduct Shaping Operations Division Mission Essential Task: Conduct Deliberate Attack		
BATTLE TASK	UNIT TASK SELECTED	BATTLEFIELD OPERATING SYSTEMS
Conduct Deliberate Attack	1st and 2d Brigade	Maneuver
Conduct Deep Attack	Aviation Brigade	Maneuver
Provide Fire Support for Combat Operations	DIVARTY	Fire Support
Reduce Complex Obstacles for Division Deliberate Attack	Engineer Brigade	Mobility / Counter-mobility / Survivability
Provide and Manage DS Combat Service Support	DISCOM	Combat Service Support
Conduct Intelligence and Electronic Attack Operations	MI Battalion	Intelligence
IOM Tactical Communications Networks (C4I) for the Division	Signal Battalion	Command and Control
Coordinate Air Defense C3I and Directed Early Warning	Air Defense Artillery Battalion	Air Defense

Figure 3-9. Example List of Division MSC and Separate Battalion Battle Tasks that Support a Mission Essential Task

… and Horizontal Linkage between Staff Elements

Element/Section	Staff Mission Essential Task
S1	Provide Personnel Services Support
S2	Conduct Intelligence Preparation of the Battlefield
	Develop an R&S Plan
S3	Plan Operations using MDMP
	Prepare OPLAN/OPORD
	Develop Task Organization Annex and Ops Overlay
S4	Develop Logistics Estimate
S5	Coordinate Host Nation Support
S6	Establish Information Network
DECOORD	Coordinate Fire Support
ENGR	Conduct M/CM/S Operations
ADA LNO	Conduct ADA Planning and Coordination
AVN LNO	Conduct Army Aviation Planning and Coordination
USAF ALO	Conduct A2C2 Management and Control Activities

Figure 3-7. Example of Brigade Staff METL

Vertical/Horizontal Mission to Task Linkage – Joint Perspective

Sample JMET

JMET: Coordinate Theater-wide Information Operations (IO) (ST 5.5)

Organization: J-3

- Conditions
  - C 2.3.2.3 Flexilibility of Warfare Style (Flexible)
  - C 2.4.4 Theater Intelligence Organizations (Mature)
- Standards
  - 90 percent of subordinate plans have integrated C2W efforts
  - 10 days to achieve information superiority
- Supporting Tasks - Identify Theater Issues and Threats (ST 2.4.1.1)
  - Conditions
    - C 2.3.2 Military Style (Predictable)
  - Standards
    - 10 hours or less to identify enemy COG
- Command-linked Tasks - Support National and JTF Surveillance Reconnaissance Requirements (ST 2.2.2)
  - Conditions
    - C 1.3.2 Visibility (High)
  - Standards
    - 90 percent of JOA has surveillance coverage

Vertical Linkage

Horizontal Linkage

Sample METL – Army Brigade

Alert and Deploy the Brigade

- Draw and upload basic/operational loads
- Conduct soldier readiness / administrative / logistic preparation for overseas movement
- Deploy advance parties or liaison officers
- Move by road or rail to APOE or SPOE
- Upload equipment at APOE or SPOE

Conduct Attack

- Attack a Moving Enemy
- Attack a Stationary Enemy
- Movement to Contact

Conduct Defense

- Conduct a Mobile Defense
- Conduct an Area Defense

Conduct Support Opns

- Domestic Support Operations
- Foreign Humanitarian Assistance

Conduct Stability Opns

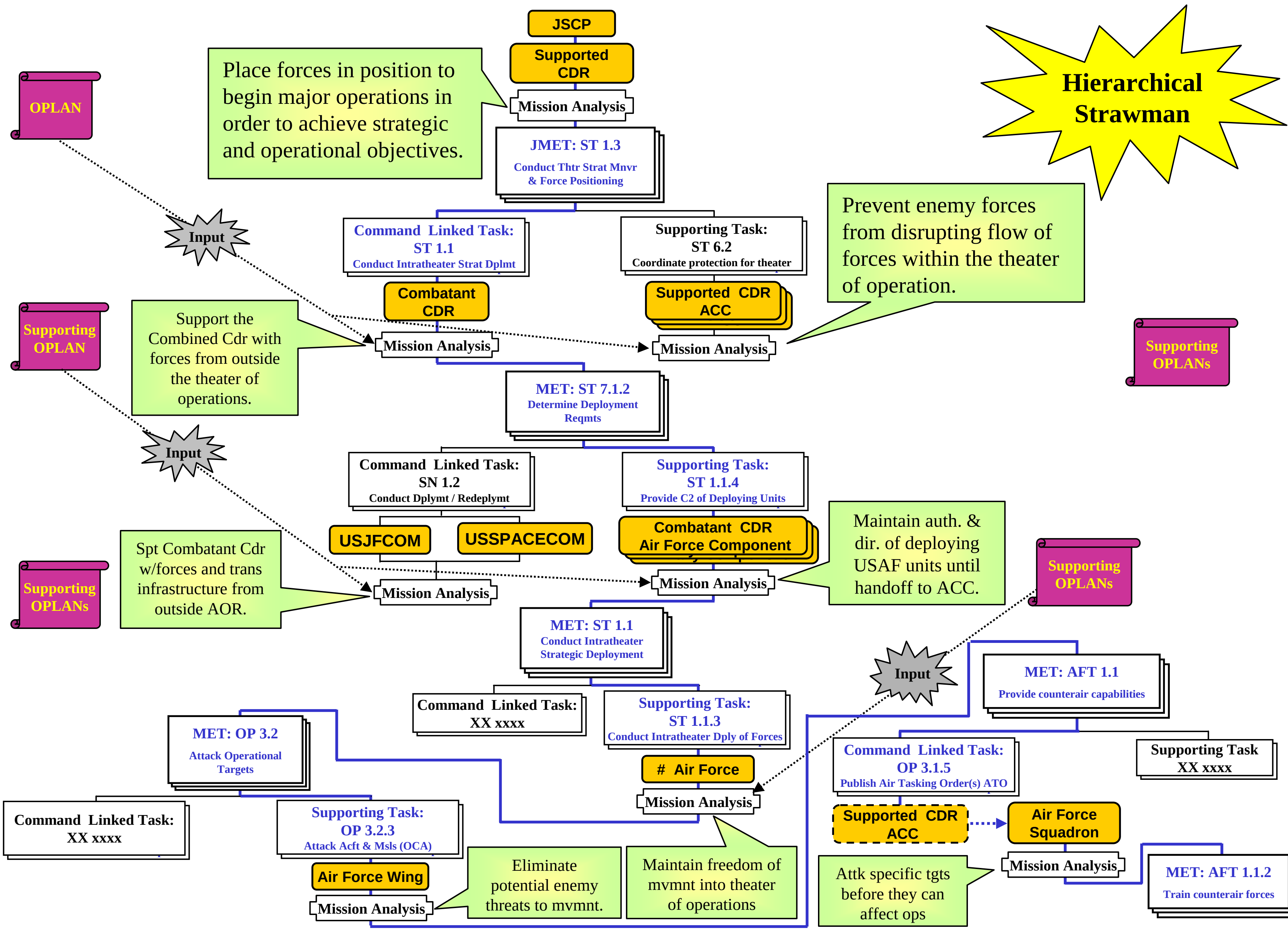
- Peacekeeping Operations
- Combat Terrorism
- Support Counter-Drug Operations

Conduct Sustainment Operations

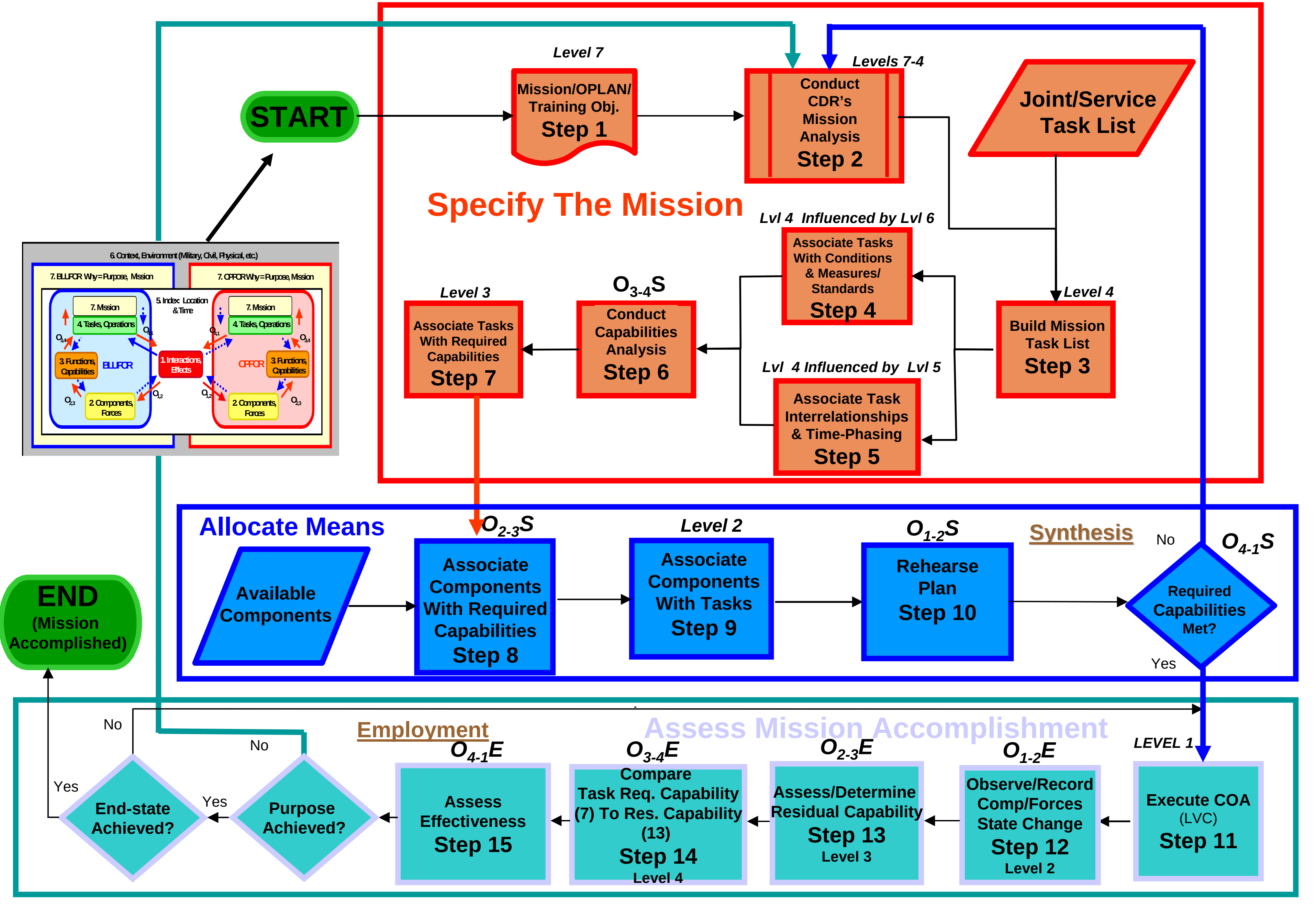
- Provide medical treatment and evacuation (air and ground)
- Move by air/surface transportation
- Manage Terrain
- Recover and evacuate disabled equipment
- Control reconstitution of subordinate units
- Conduct mortuary affairs operations

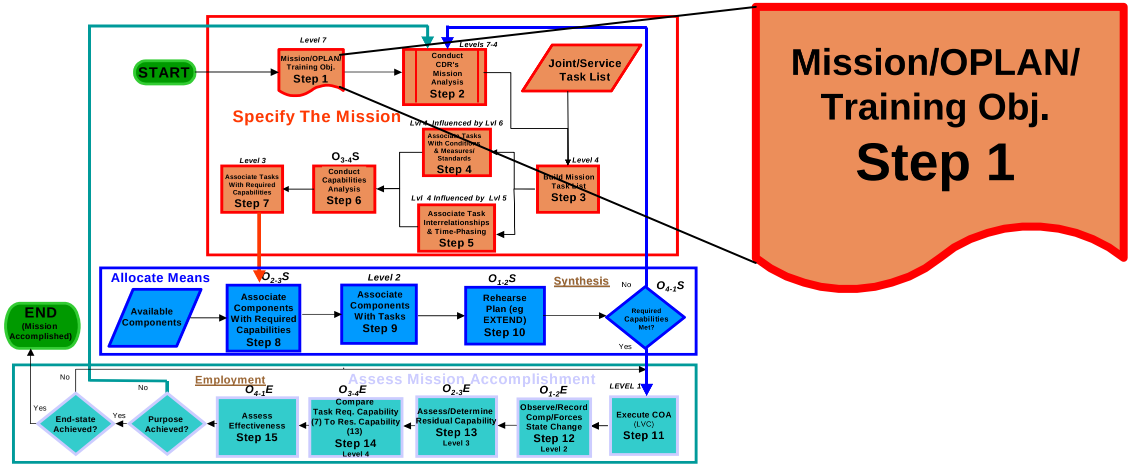
Figure 3-2. Example of Brigade Tasks Derived from Wartime Operational Plans and External Guidance

Putting it All Together – COCOM to Squadron Linkage example



MMF Formal Process Diagram





*Need **mission types** and*

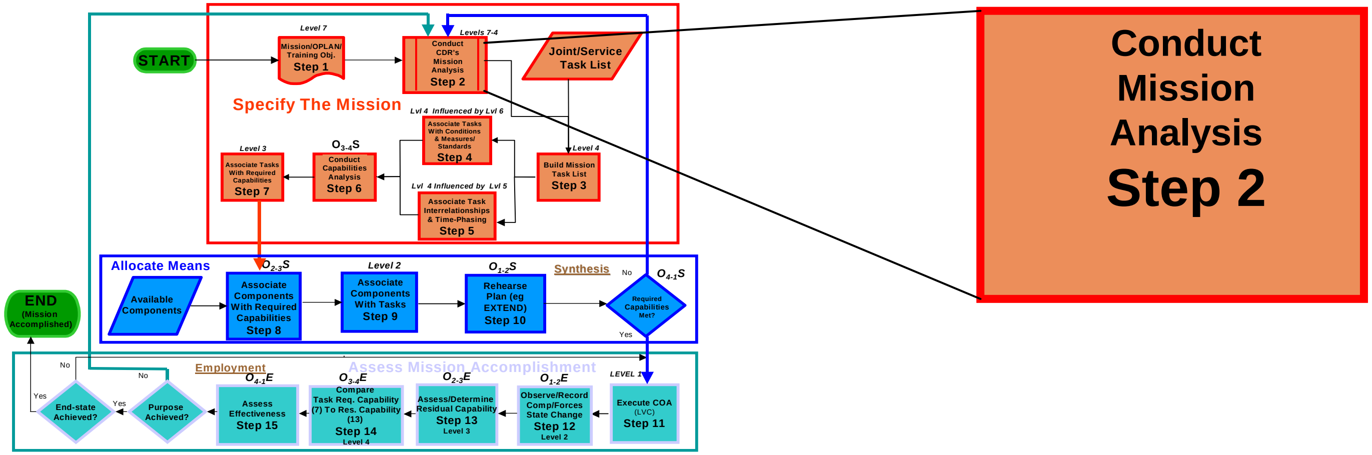
***Scenario/vignettes** from Requirements Documents and/or User Representative*

- What Mission(s) is/are to be performed by the object under test?
    - Doctrinal mission type(s) (I.e. Stability Ops mission(s))
        - Doctrinal references to be used (Concepts, FM's, etc.)
- What Operating Environment is to be used to set the conditions for performance of the mission? What is the Road to War that established the Operational context for each each test vignette? What approved scenario has been selected to provide the appropriate environment and context?
    - Scenario/vignette documentation (MDMP products, maps or map references, COA statements and sketches, plans and orders, annexes, graphics, etc.).
    - Including selected OPLAN/OPORD products at least two levels up.

UA Vignette / Scenario Relationship

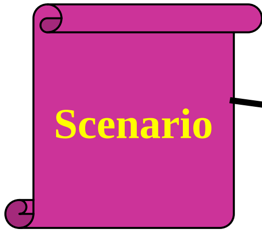
Who develops/ Are there more?

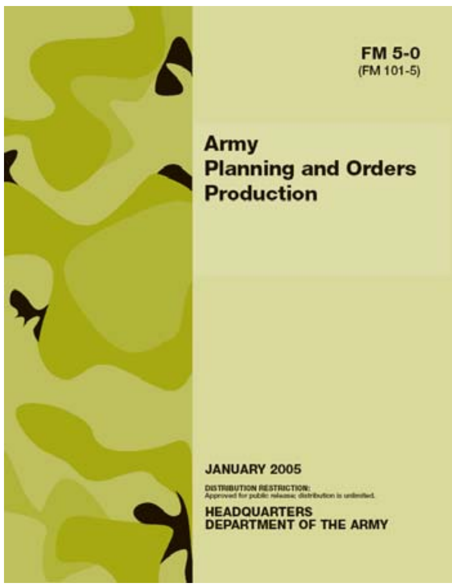
Vignettes \ Scenarios	Caspian		Balkan		SW Asia		NE Asia	
	Bluefor	Opfor	Bluefor	Opfor	Bluefor	Opfor	Bluefor	Opfor
Vig #1 Entry Operations	Product? OPORD, storyboards etc							
Vig #2 CA Ops in major urban areas								
Vig #3 Mounted Exploitation/Pursuit Ops								
Vig #4 Rapid Advance to enemy COG								
Vig #5 AASLT in mountain terrain								
Vig #6 Dismt Ops to conduct raid on decisive point in jungle								

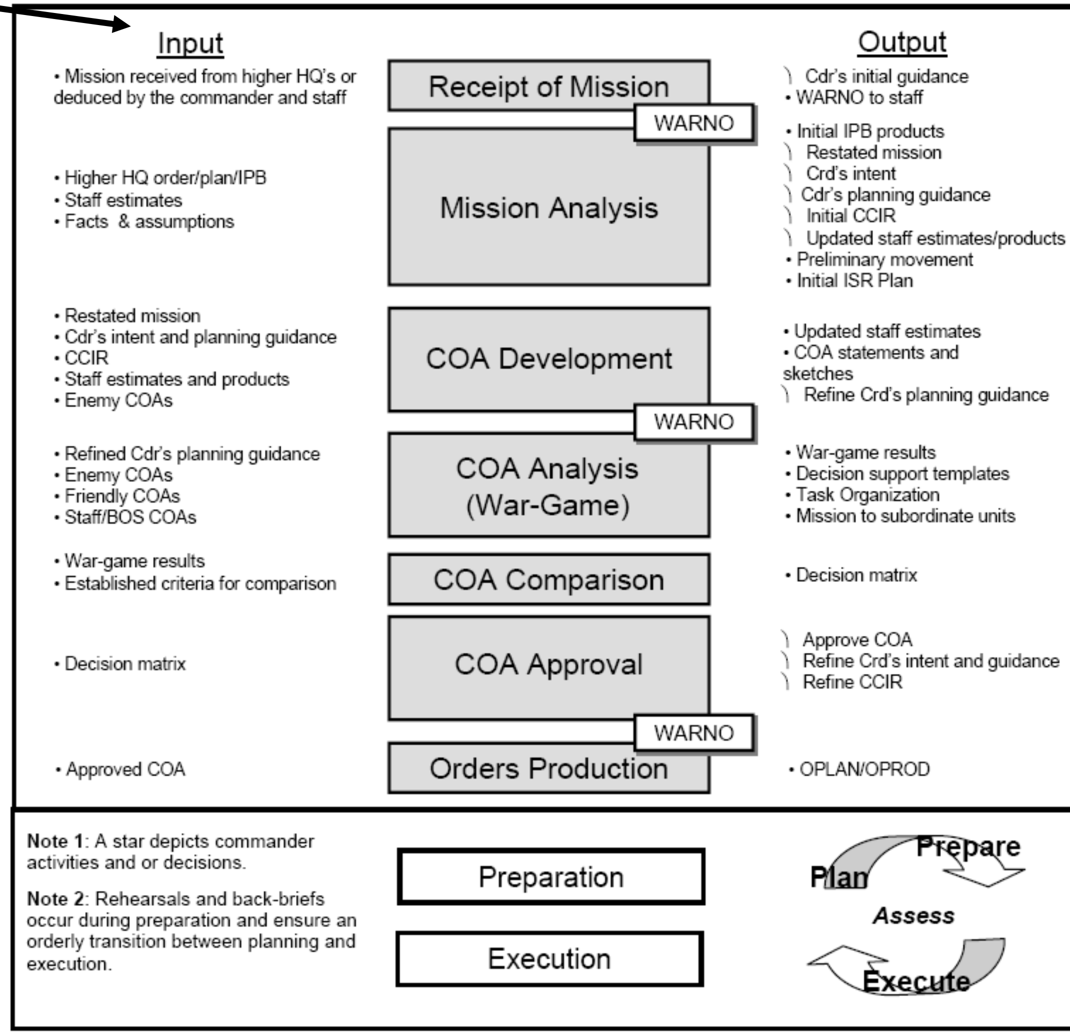


- Use the appropriate (Joint/Service Specific) doctrinal planning and decision making process to:
  - Analyze the assigned or perceived mission and determine/document the specified and implied tasks (with their associated purpose) required to accomplish the mission.
  - Determine and document facts, limitations, assumptions and constraints.
  - Describe Operating Environment and Impact on Operations
  - Describe Current Situation and Events leading up to it.
  - Describe Threat Situation, Mission, Intent, Vulnerabilities, etc.

MDMP







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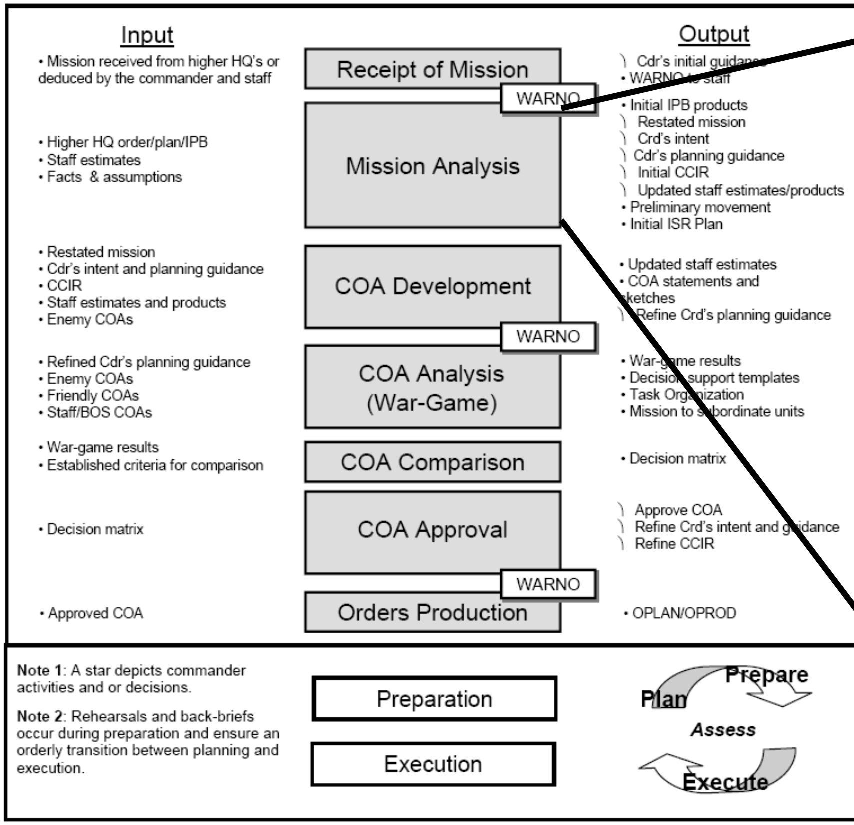
Mission Analysis Process…



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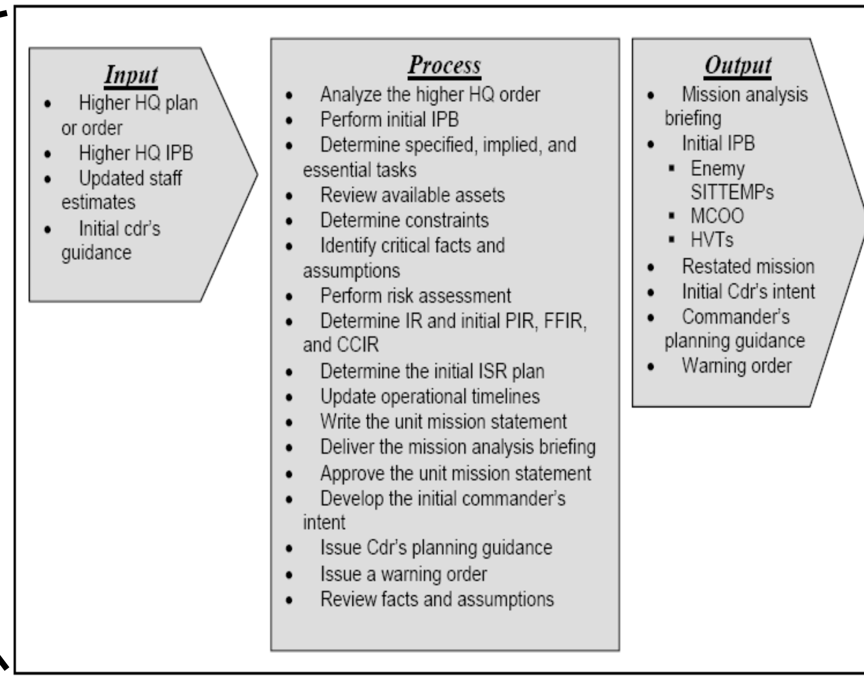


Figure 3-5. Mission Analysis

Yields MMF Level 7 – 5 data, list of Mission Tasks (big part of Level 4), and initial Force Listing (Level 2)

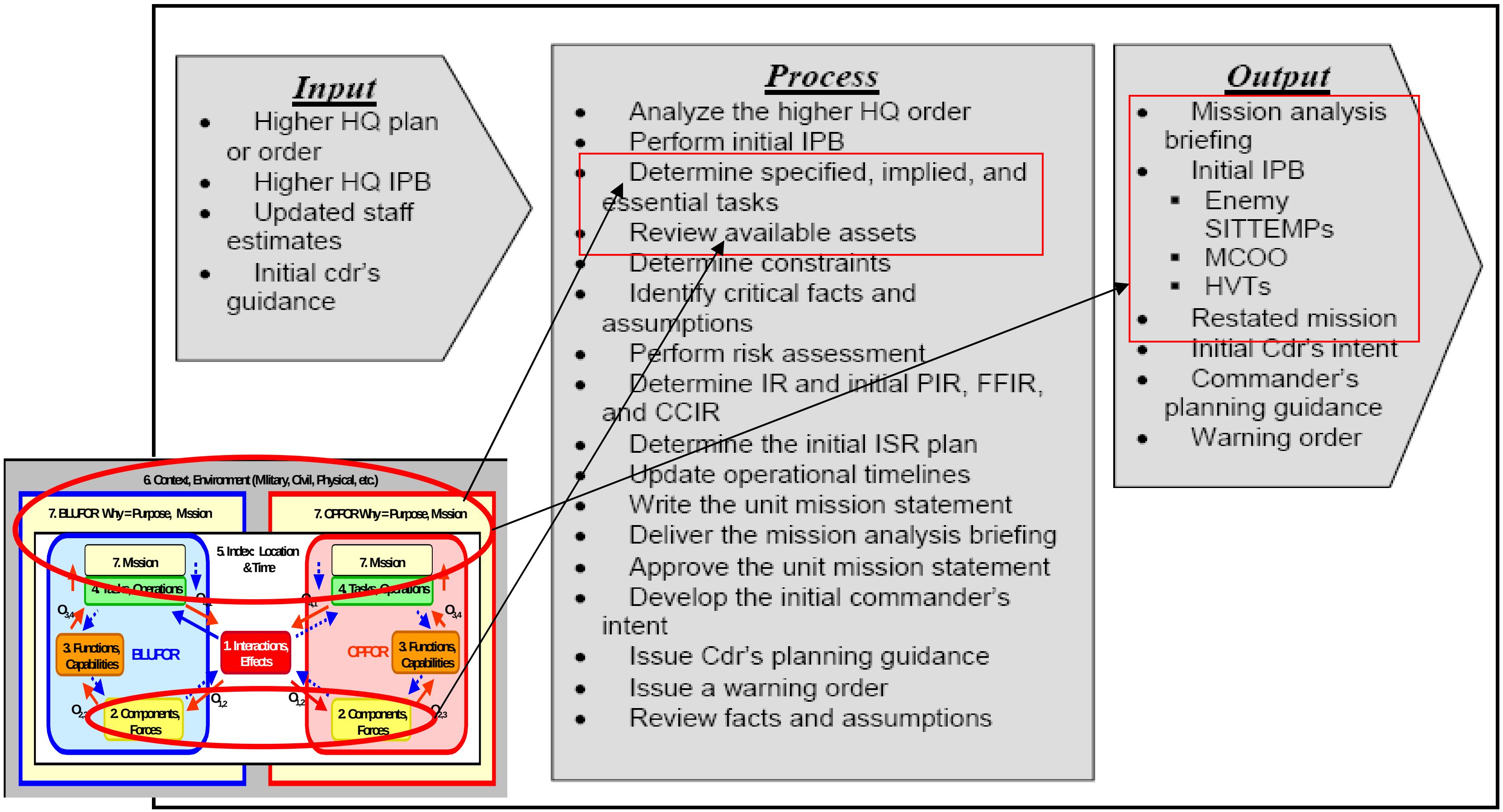


Figure 3-5. Mission Analysis

Conditions

- **Conditions are variables of the operational environment or situation that may affect performance.**

- Environment is the immediate situation or circumstance in which tasks must be performed.

- Conditions impact the ability to perform a task (e.g., security of lines of communication impact the ability to sustain joint task force operations).

Conditions

C 1.0 PHYSICAL ENVIRONMENT

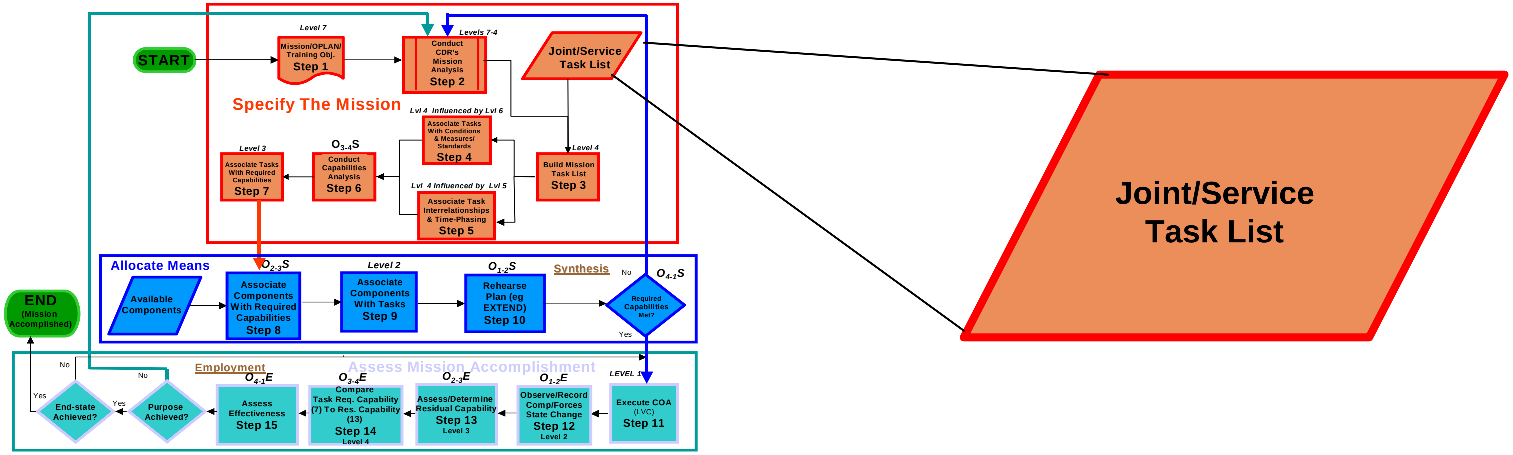
C 2.0 MILITARY ENVIRONMENT

C 3.0 CIVIL ENVIRONMENT

(Friendly, Enemy)

C 1.1 Land
C 1.2 Sea
C 1.3 Air
C 1.4 Space

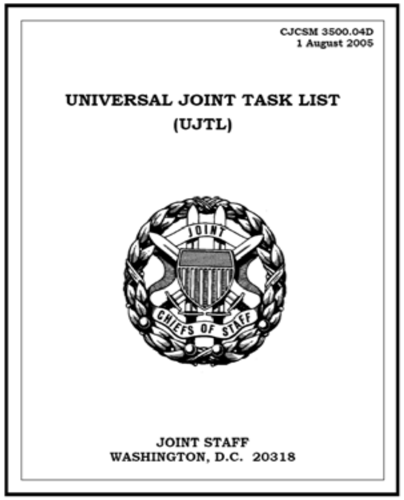
C 2.1 Mission
C 2.2 Forces
C 2.3 Command, Control & Communications Related Conditions
C 2.4 Intelligence Related Conditions
C 2.5 Deployment, Movement, and Maneuver Related Conditions
C 2.6 Firepower Related Conditions
C 2.7 Protection Related Conditions
C 2.8 Sustainment Related Conditions
C 2.9 Threat Related Conditions

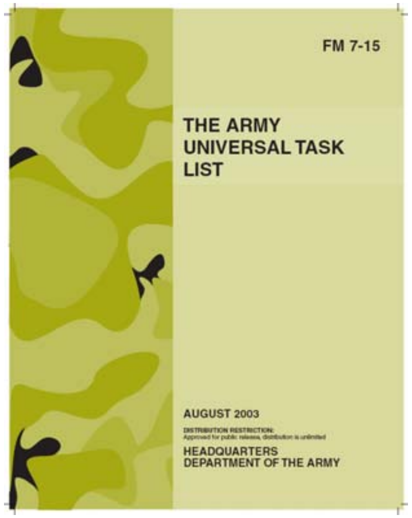


- Determine/select the source of tasks to be used to describe mission activities for the object under test.
    - Examples: UJTL, AUTL, UNTL, MCTL, IATL, FCS Single Integrated Task List (SITL), Soldier Training Plan (STP), Soldiers Manual of Common Tasks (SMCT), etc.
    - Ensure the selected task list is current and contained in the data base to be accessed by the task management tool (I.e. JTIMS, DTMS, ATIA, etc.)
- Determine/select an alternative source for acceptable substitute tasks in the event primary source does not have an adequate task description for a particular activity*

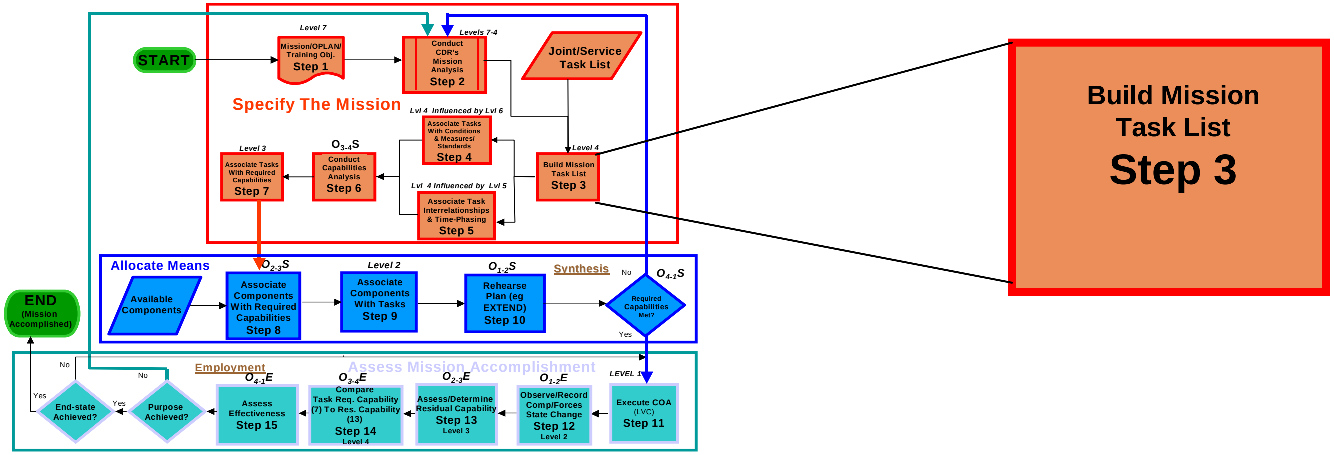
- *Tasks should come from authoritative (i.e. approved) source. Recommend you avoid using newly constructed and not yet approved tasks.*

Authoritative Task Lists





- Several authoritative sources available to describe elements of military operations
- Authoritative task lists are easily stored and maintained in data bases for access and manipulation



- Convert the mission (specified, implied) tasks from step 2 into tasks from the selected authoritative task list.

- Use doctrinal references for the types of missions and operations to be conducted to identify supporting tasks by functional area or Battlefield Operating System, or some similar organizing principle.

    - Approved doctrinal templates of tasks already exist for many doctrinal mission types and should be used as a starting point wherever possible. Potential sources include the UJTL, Navy NMETL's, and Army Mission Training Plans.

    - Templates will likely have to be modified to reflect specific aspects of the operational scenario.

- Capture, document and organize the resulting list of tasks into a data base mission file (see next slide)

    - This should be done in conjunction with Step 2, Mission Analysis or as closely thereafter as possible

Basis for Conversion to Authoritative Task Language

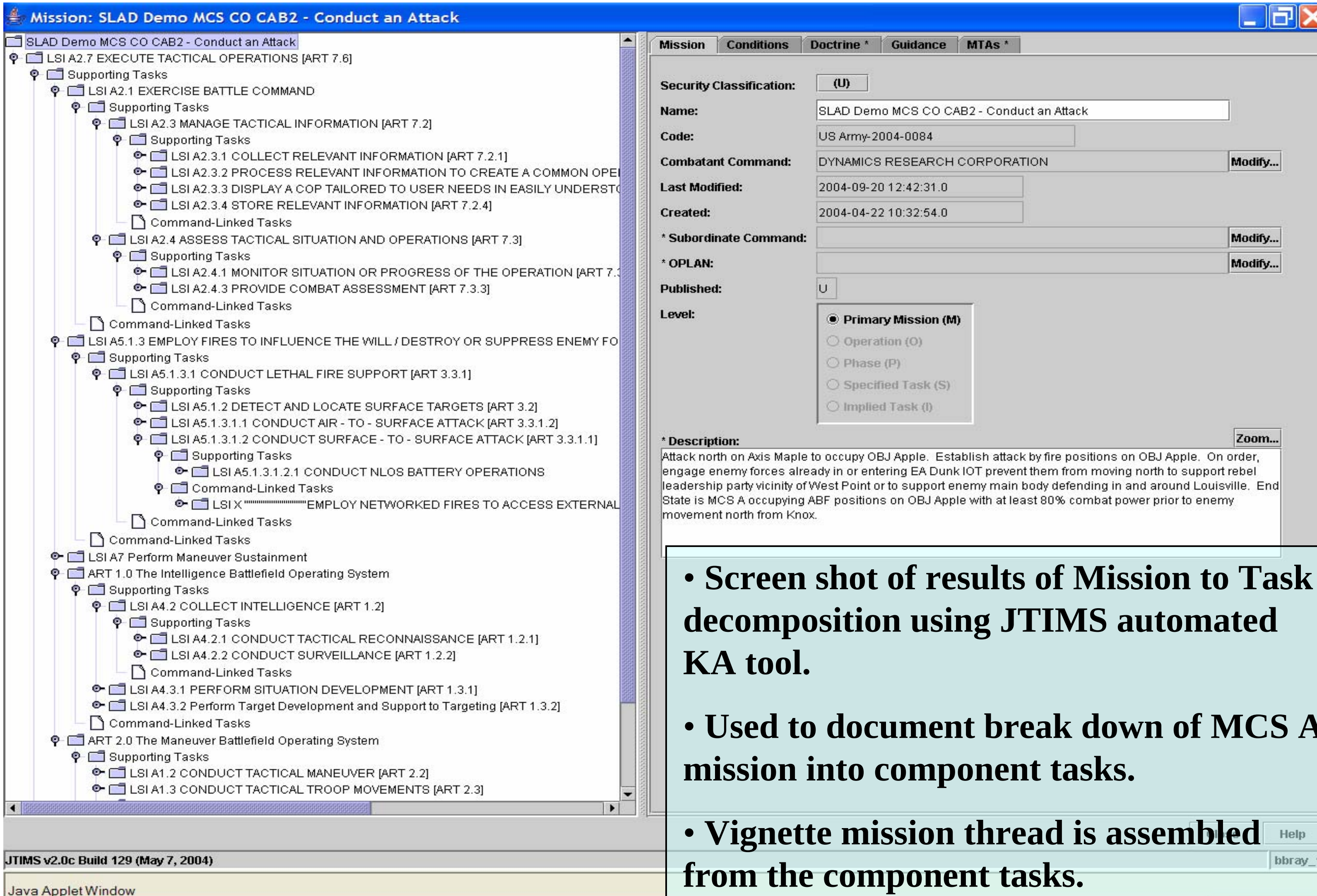
JMETL Development Guidance (CJCSM 3500.03A, 1 Sept 2002)
Perform Mission Analysis to determine specified and implied tasks.
Select appropriate UJTL tasks in JTIMS that are descriptive of specified and implied tasks. Result is list of Mission Tasks which are capabilities associated with each assigned mission
Determine which tasks are essential by applying commander-approved essentiality criteria for each mission to each mission task.
Assign responsible organizations, conditions and standards for that mission. Conditions are selected if they affect task performance. Standards relate to task performance under mission conditions.
Assign supporting and command linked tasks. Completed JMETS for all assigned missions with supporting and command linked tasks constitute a command’s JMETL. Supporting tasks = Mission for subordinate organization

Sample Conversion of specified, implied tasks to authoritative task list tasks

	Mission to task analysis results – Specified and implied tasks	Specified and implied tasks converted to tasks from authoritative task lists	Task Ref. Number
1	Establish the FOB	Establish Forward Operating Base	FCS 7-1-U4014
2	Select/Establish AORs	ish and Conduct Command Post Operations to Support Tactical Oper	ART 7.1.1
3	Select FOB location	Establish Forward Operating Base	FCS 7-1-U4014
4	Gain and maintain situational understanding (e.g., the COP) of the battle space as it applies to JIM elements	Gain and maintain situational understanding (e.g., the COP) of the battle space as it applies to JIM elements which may affect the Unit	FCS17-6-S1003
17	C2 the UA/CAB (Conduct Battle Command)	C2 the UA/CAB (Conduct Battle Command)	FCS 71-6-U2052
24	Maintain Force Protection (Coordinate Force Protection Activities)	Coordinate Force Protection Activities	FCS71-6-U2520
25	Conduct Battalion Force Protection Activities	Conduct Battalion Force Protection Activities	FCS 71-1-S2520
26	Protect force from fires	Conduct Defense Maximizing Collaborative Networked Fires	FCS17-6-S2604
27	Establish Sensor Coverage Plan	Integrate Sensor Operations	FCS 71-6-U2155
28	Control Sensor Platoon Operations	Control Sensor Platoon Operations	FCS6-3-U6017
29	Perform Surveillance and Target Acquisition (Radar)	Perform Surveillance and Target Acquisition (Radar)	FCS6-4-U6045
30	Conduct Information Assurance	Conduct Information Assurance (IA)	FCS 71-5-U3124
31	Establish Reponsibilities within the FOB	Task Organize For Operations	ART 7.5.3
32	Integrate Contract/Contractor Support Personnel Into UA Sustainmei	ɜgrate Contract/Contractor Support Personnel Into UA Sustainment Operatic	FCS17-6-S1406
33	Secure FOB locations (Conduct Rear Area and Base Security Operat	Conduct Rear Area and Base Security Operations	ART 5.3.5.4.1
34	Conduct Zone/Area Reconnaissance	Conduct Zone/Area Reconnaissance	FCS 7-2-S4404
35	Area Surveillance	Conduct Area Surveillance	FCS17-2-U4011
36	Assured Mobility (Coordinate Assured Mobility Operations)	Coordinate Assured Mobility Operations	FCS 71-6-U2525
37	Clear Obstacles	Clear Obstacles	ART 5.1.1.2
38	Conduct Route Clearance	Conduct Route Clearance	ART 5.1.1.2.2
39	Area Access (Conduct Area Clearance)	Conduct Area Clearance	ART 5.1.1.2.1
40	Occupy a Tactical Assembly Area	Occupy a Tactical Assembly Area	FCS 7-1-S4200
41	Non lethal response to security threats (Engage and Control Civilian Pc	Engage and Control Civilian Populations	FCS 7-2-S4205
42	Secure civilian population (Secure Civilians during Operations (SOSO))	Secure Civilians During Operations (SOSO)	FCS 20-3-S6214
43	Control Networked Fires	Control Networked Fires	FCS 71-6-U2360
44	Coordinate Early Warning	Coordinate Early Warning	FCS 71-6-U2366
45	Defend the FOB	Conduct Area Security Operations.	FCS7-2-S4010
46	Entry/Exit Control		NA
47	Plan ECPs and Provide Resources	No Match	NA
48	Establish the ECP	Control Checkpoint(s) (SOSO)	FCS 20-2-C6203
49	Operate an ECP	Operate Checkpoint (SOSO)	FCS20-3-S6207
50	Prepare Protective Positions	Prepare Protective Positions	ART 5.3.1.3
51	Employ Protective Obstacles	Employ Protective Obstacle(s)	FCS 7-3-U4025
52	Construct Protective Earth Wall, Berms and Revetments	Construct Protective Earth Walls, Berms, and Revetments	ART 5.3.1.3.1
53	Construct Vehicle, Information System, Equipment, and Material Protective Positions	Construct Vehicle, information System, Equipment, and Material Protective Position	ART 5.3.1.3.2

Ready

Sample JTIMS Mission Task File (screen shot)



- **Screen shot of results of Mission to Task decomposition using JTIMS automated KA tool.**
- **Used to document break down of MCS A mission into component tasks.**
- **Vignette mission thread is assembled from the component tasks.**

Operational Template from UJTL, CJCSM 3500.04D, dtd. 1 August 2005

AIR ASSAULT

Description:
A forcible entry operation conducted by the US Army's air assault units to seize a lodgment (normally an airfield) and defend it while the JFC executes a rapid build-up of combat power.

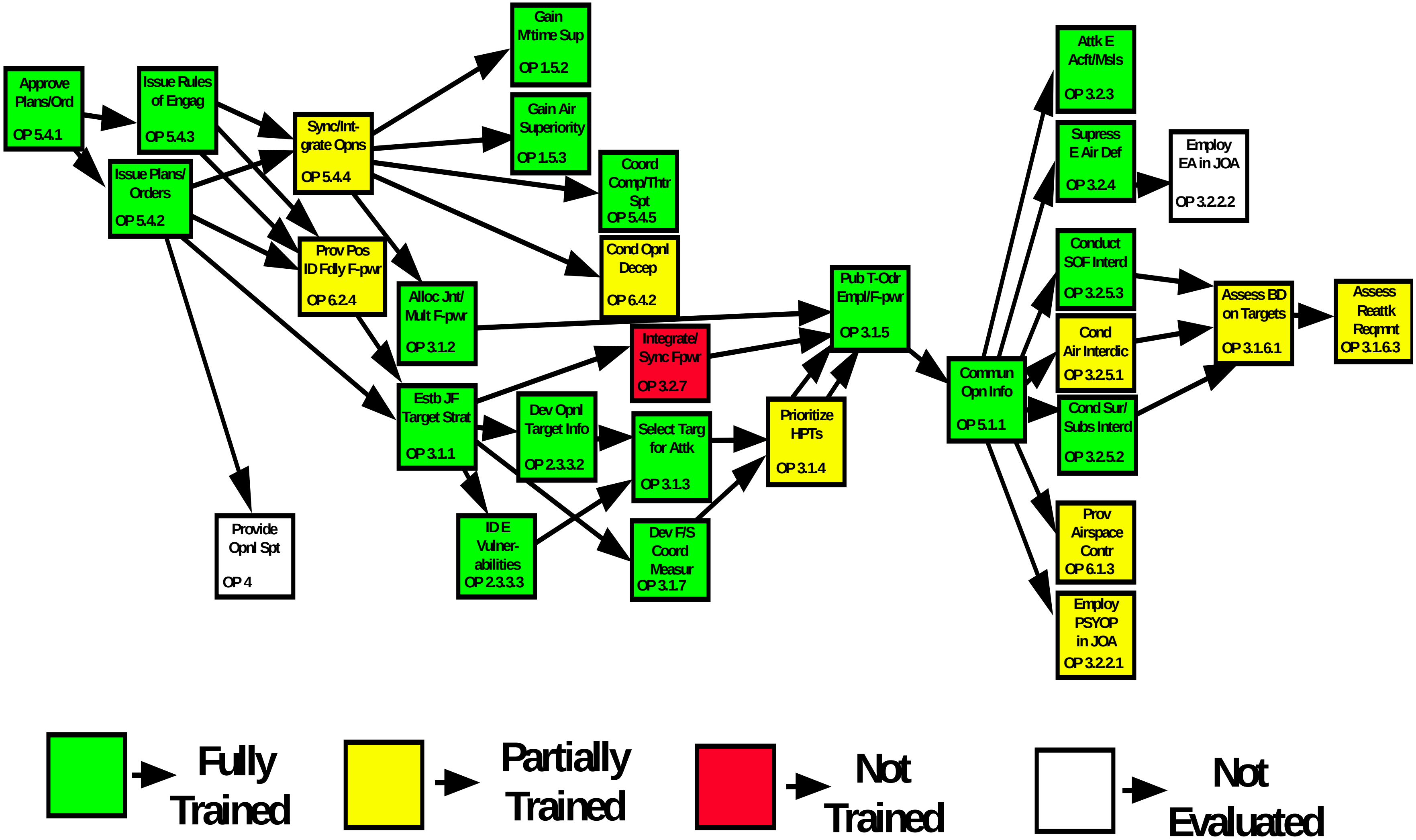
Search Documents: CJCSM 3500.04B, CJCSM 3500.02B, JP 1-02, CJCSM 3500.04A, CJCSM 3500.05

Tasks:

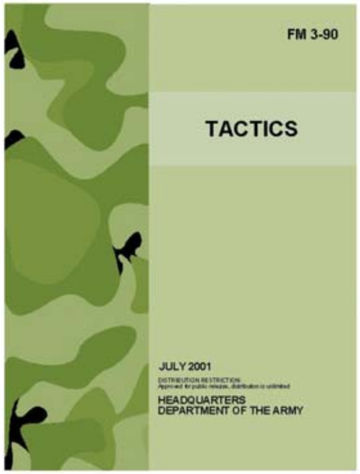
TASK	DESCRIPTION
ST 1.3.3	Synchronize Forcible Entry in Theater
ST 1.3.4	Integrate Direct Action in Theater
ST 5.4.2	Synchronize Joint Operations and Subordinate Campaign Plans
ST 6.2.1	Coordinate the Preparation of Strategically Significant Defenses
ST 7.1.3	Tailor Joint Forces for Deployment
OP 1.2.4.3	Conduct Forcible Entry: Airborne, Amphibious, and Air Assault
OP 1.2.4.4	Reinforce and Expand Lodgment
OP 1.2.5	Conduct Offensive Operations in the Joint Operations Area
OP 1.2.6	Conduct Defensive Operations in the Joint Operations Area
OP 1.3.1	Overcome Operationally Significant Barriers, Obstacles, and Mines
OP 1.5.1	Control of Operationally Significant Land Area in the Joint Operations Area
OP 2.4.1	Evaluate, Integrate, Analyze, and Interpret Operational Information
OP 3.1.7	Employ Fire Support Coordination Measures
OP 3.2.7	Synchronize Operational Firepower
OP 5.3.1	Conduct Operational Mission Analysis
OP 5.3.3	Determine Operational End State
OP 5.4.4	Synchronize and Integrate Operations
OP 5.5.1	Develop a Joint Force Command and Control Structure
OP 6.1.4	Counter Enemy Air Attack (Defensive Counterair (DCA)) in the Joint Operations Area
OP 6.5.5	Integrate Host-Nation Security Forces and Means

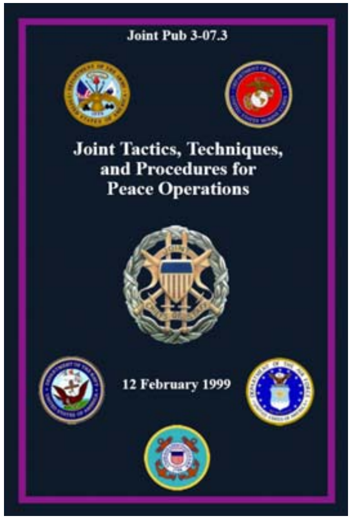
(Operations Template Development)

Systems Approach Using JTS

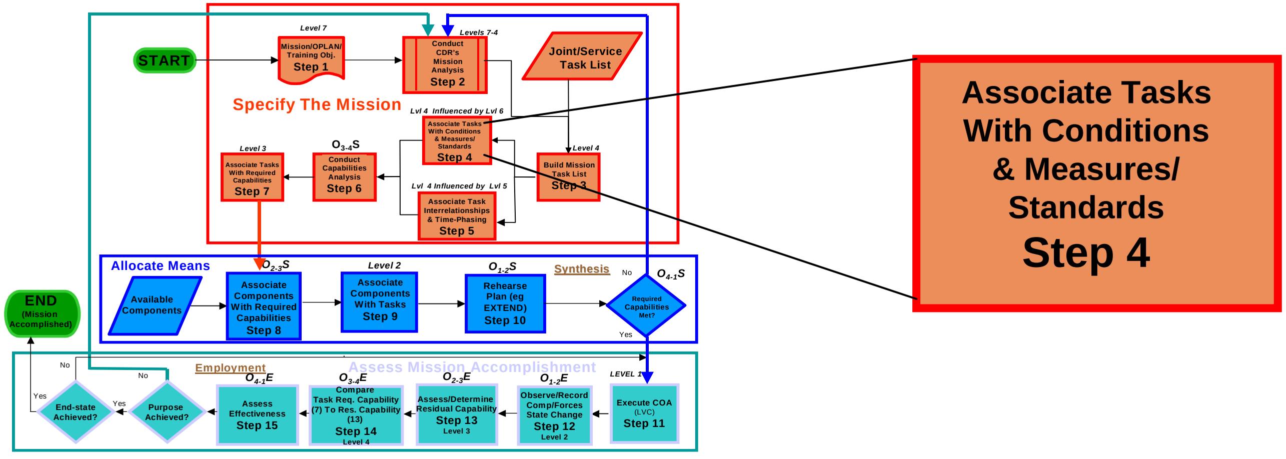


Doctrinal Sources





- Online Joint and Service digital libraries provide a ready reference to doctrine and TTPs for identifying supporting tasks



- Develop, select and wargame a Course of Action COA to accomplish the mission
  - Conducted using:
    - Maps of the Scenario area of operations
    - COA development and wargaming steps from Military Decision Making Process (MDMP)
    - Laptop computer with In-Focus projector to project COA sketch for reference in conference room/work area
    - MS Project application software*
  - Prior to wargaming, one DRC SME set up the Mission file for the base COA in MS Project by:
    - Setting initial parameters in terms of duration of the vignette and time increments to be used.
    - Importing tasks from the step 3 mission task report generated by JTIMS into the tasks portion of the Mission file

Develop a COA

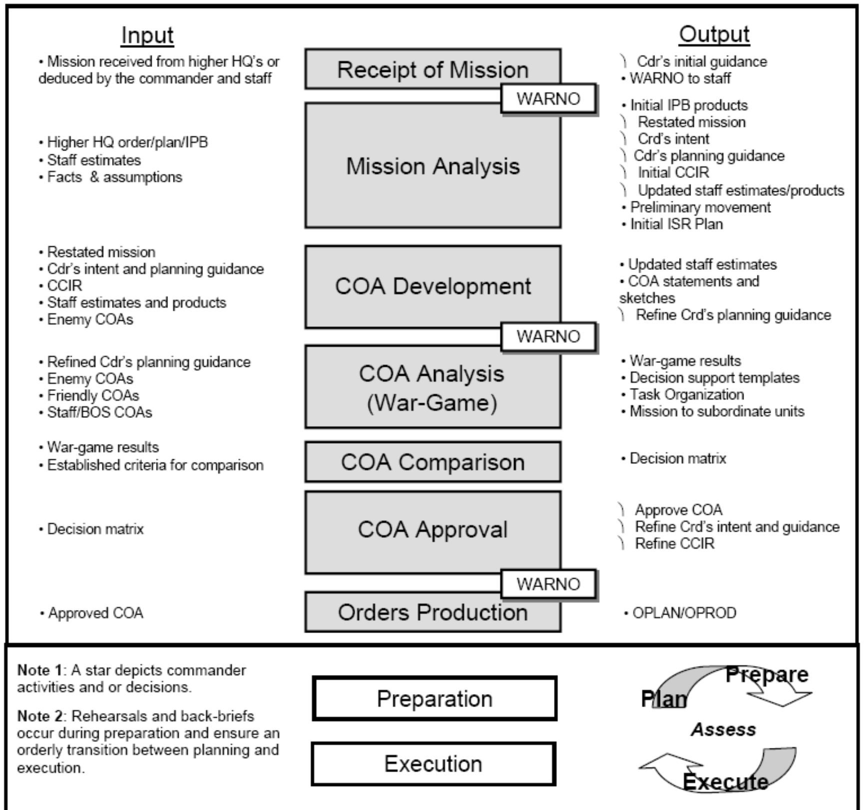


Figure 3-1. The Military Decision Making Process

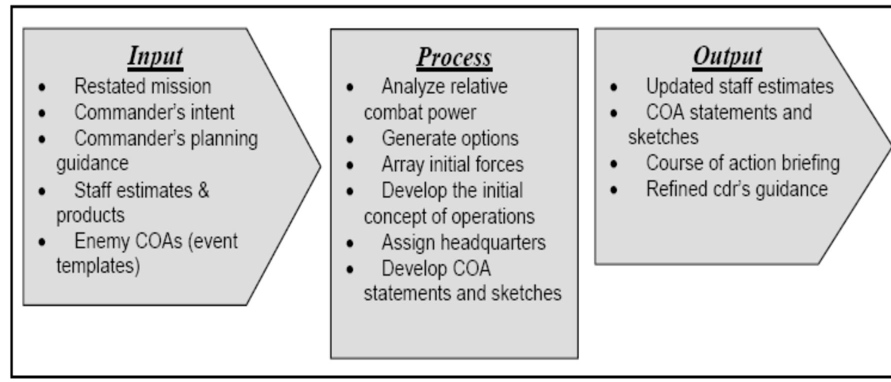
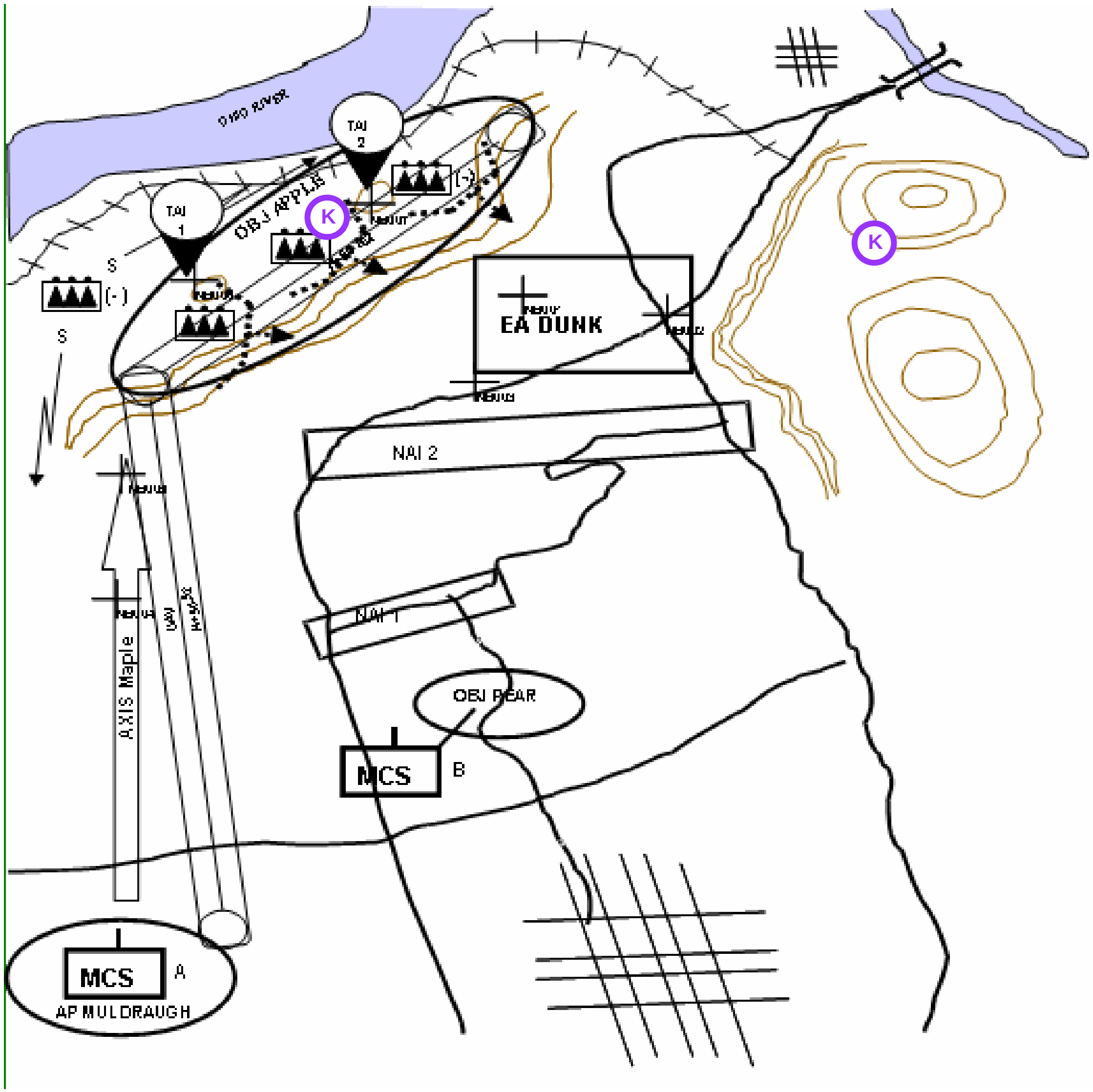


Figure 3-8. COA Development

Will Convert COA into Mission Thread Structure…

Sample COA Sketch and Statement



MISSION:

Attack north on AXIS Maple and seize OBJ APPLE NLT 0600 hrs. Establish attack by fire positions on OBJ APPLE and engage enemy forces already in or entering EA DUNK IOT block enemy forces from moving north to support rebel leadership vic Westpoint or support enemy forces defending in and around Louisville.

ENDSTATE:

Enemy forces vicinity of Knox remain south of EA DUNK until friendly operations vicinity of Westpoint are completed.

Fully Developed COA Statement

MISSION: At 170400Z March 03, 52d ID (Mech) attacks to defeat elements of the 12th DTG in AO LION to protect the northern flank of the 55th AD, the 21st (US) Corps main effort.

INTENT: The purpose of this attack is to prevent repositioning of 12th DTG forces to the south and interfering with 21st (US) Corps decisive operation (the 55th AD's seizure of OBJ STRIKE). Key tasks are:

- Destroy 73d Brigade Tactical Group (BTG) south of the METRO CITY-CENTRAL TOWN-RIVER TOWN Line to prevent their repositioning south into 55th AD's AO.
- Seize OBJ SLAM by 181800Z MAR 03 to secure the northern flank of the 55th AD.
- Defeat the 12th DTG's reserve (23d BTG) vicinity EAST TOWN to prevent them from interfering with the seizure of OBJ SLAM.

At end state, the corps' right flank is secure with two brigades consolidated in defense positions vicinity OBJ SLAM. The division is prepared to conduct follow-on offensive operations to defeat enemy to PL RED.

DECISIVE OPERATION: Armor Bde #1 passes through the southern Mech Bde # 1 east of PL AMBER and attacks to seize the key terrain vicinity of OBJ SLAM in order to protect 55th AD's northern flank.

SHAPING OPERATIONS: Mech Bde #1 in the south, the initial main effort, conducts a penetration to destroy enemy force vicinity PL AMBER to create enough maneuver space for Armor Bde #1 to pass to the East without interference from the 73d BTG in order to seize key terrain vicinity of OBJ SLAM and protect the northern flank of the 55th AD. Armor Bde #1 becomes the main effort after conducting forward passage of lines with Mech Bde # 1 and then accepts battle-handover along PL GREEN. Mechanized Bde #1 then follows and supports Armor Bde #1 and the division reserve by attacking east to clear remaining elements of the 73d from PL Amber to PL Green in order to protect the rear of both units.

The division reserve, an armor-heavy task force, initially follows Mechanized Bde #1 with the following priorities of commitment: 1). Contain enemy forces capable of threatening Armor Bde # 1's passage through Mechanized Bde # 1 allowing battle-handover to occur along PL Green. 2). If not committed west of PL Green, follows Armor Bde # 1 and blocks enemy force capable of threatening this brigades movement east enabling it to seize the key terrain vicinity of OBJ SLAM and protect the north flank of the 55th AD.

In the north, Mech Bde #2 attacks east to fix the 72d BTG denying it the ability to interfere with the division's decisive operations in the south. The division cavalry squadron conducts a moving flank screen along the division's northern boundary to provide early warning of enemy forces attacking south into the northern flank of Mech Bde # 2.

Figure 3-12. Course of Action Statement (COA #1)

COA # 1 (continued)

Once Mech Bde #1 crosses PL AMBER (LD), the division attack helicopter battalion (AHB) attacks along AIR AXIS SIDNEY to destroy the enemy tank battalion vicinity WEST TOWN to protect then northern flank of Mech Bde #1 and allowing it to pass Armor Bde #1 east. Once Armor Bde #1 accepts battle-handover along PL GREEN, the AHB attacks along AIR AXIS GIZMO to defeat the 23d BTG south and east of the NORTHERN MOUNTAINS to allow Armor Bde. #1 to seize the key terrain vicinity of OJB SLAM and protect the northern flank of the 55th AD.

Division fires will: 1). Conduct SEAD along AIR AXES SIDNEY and GIZMO to allow the AHB to destroy the enemy tank battalion vicinity WEST TOWN and to defeat the 23d BTG south and east of the NORTHERN MOUNTAINS, respectively; 2). Conduct counter fire to neutralize two battalions of the 12th DTG's Integrated Fires Command (IFC) to prevent it from massing fires against the southern two brigades; 3). Provide suppressive fires against 73d BTG defenses along PL AMBER to enable Mech #1's penetration.

Division ISR operations focus on: 1). Identifying the location and disposition of the 73d BTG battle zone to determine optimal point of penetration for MECH Bde # 1 along PL AMBER; 2). Location and disposition of the 12th DTGs IFC assets to assist counter fire efforts; 3). Location and intentions of the enemy tank battalion and ADA assets vicinity WEST TOWN, and location and intention of the 23d BTG, the enemy's reserve, vicinity the NORTHERN MOUTAINS, to assist the AHB attacks.

SUSTAINING OPERATION. The division support area will establish vicinity METRO CITY with MSRs SEAN and NICK as the primary routes used to sustain combat power during the attack. A mechanized company team is the division TCF with priority of responding to any LEVEL III treats to division class III supply point.

The deception objective is: commander of the 12th DTG commits his reserve, the 23d BTG, at H+10 to block penetration of US forces in the north of AO LION in order to protect the 24th DTG, the 1st Field Group's main effort. The deception story is that the division's decisive operation is in the north, with the following indicators: the initial positioning of an armor-heavy brigade in the northern portion of the rear are in AA MIKE, simultaneous attacks of two brigades abreast in the north and south, the division cavalry squadron operating on the north flank of the division AO, and early commitment of the division's AHB destroy an enemy tank battalion in the north.

Tactical risk is assumed by early commitment of the division's AHB, potentially leaving it without sufficient combat power to defeat the 23d BTG, the enemy's reserve.

Wargame a COA

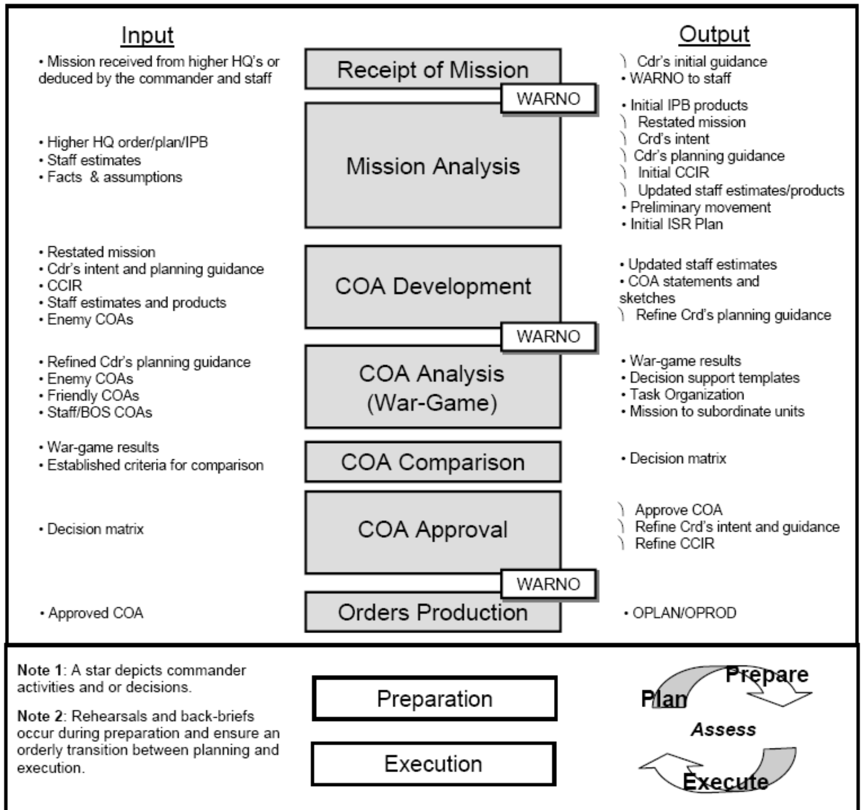


Figure 3-1. The Military Decision Making Process

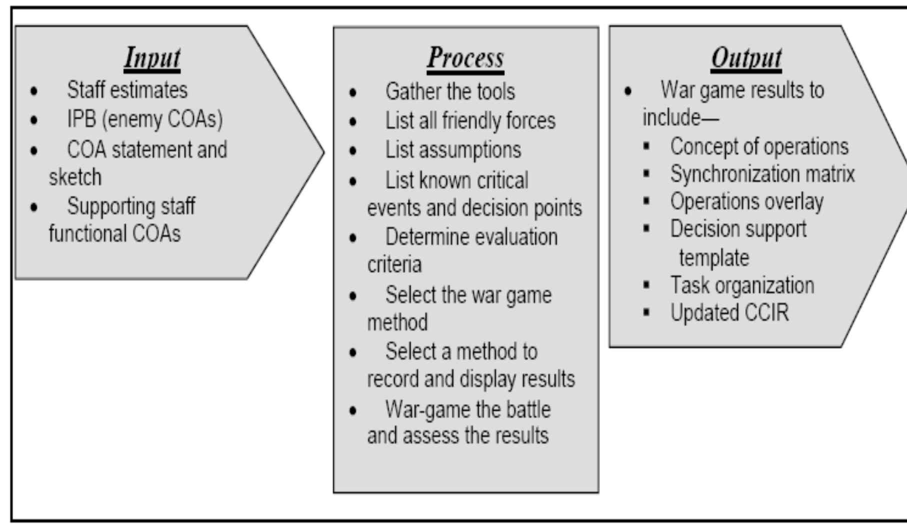


Figure 3-12. Course of Action Analysis (War Game)

Associate Tasks With Conditions & Measures/ Standards

Step 4

Continued

Generates details needed to populate Mission Tasks in order to perform meaningful evaluation

- During the wargaming process, record the results of the wargaming by:
  - Ordering mission tasks in the wargamed sequence
  - Annotating the task purpose, conditions, Measures of Effectiveness (MOE), and Measures of Performance (MOP) for each task to be observed and evaluated, based on wargaming team discussion and consensus.
  - Upon completion of initial wargaming process, review, critique and modify above results as required. Focus should be on the following questions:
    - Did we select the most appropriate task to describe the activity?
    - Is the purpose of the task clearly stated and does it make good tactical sense?
    - Do the MOEs support ability to determine if the purpose is achieved?
    - Do the MOPs support and flow logically from the MOEs and are they objectively measureable?

Wargaming generates detailed and valuable information – Who knew?

3-187. An effective wargame results in the commander and staff—

• Refining or modifying each COA, including identifying branches and sequels that become on-order or be-prepared missions.

• Refining the locations and times of decisive points.

• Identifying key or decisive terrain and determining how to use it.

• Refining the enemy event template and matrix.

- Refining the task organization, including forces retained in general support.
- Identifying tasks the unit retains and tasks assigned to subordinates.
- Allocating assets to subordinate commanders to accomplish their missions.
- Developing decision points.
- Developing a synchronization matrix.
- Developing decision support template.
- Estimating the duration of the entire operation and each critical event.
- Projecting the percentage of enemy forces defeated in each critical event, and overall.
- Identifying likely times and areas for enemy use of WMD and friendly NBC defense requirements.
- Identifying the potential times or locations for committing the reserve.
- Identifying the most dangerous enemy COA.
- Identifying locations for the commander, command posts, and INFOSYS nodes.
- Identifying critical events.
- Identifying requirements for BOS support.
- Determining requirements for military deception and surprise.
- Refining C2 requirements, including control measures and updated operational graphics.
- Refining CCIR and IR—including the LTIOV—and incorporating them into the ISR plan and Information Management plans.
- Developing the ISR plan and graphics.
- Developing IO objectives and tasks (see FM 3-13).
- Developing fire support, engineer, air defense, IO, and CSS plans and graphic control measures.
- Identifying the effects of friendly and enemy action on the civilian population and infrastructure, and how these will affect military operations.
- Identifying or confirming the locations of NAIs, TAIs, decision points, and IR needed to support them.
- Determining the timing for concentrating forces and starting the attack or counterattack.
- Determining movement times and tables for critical assets, including INFOSYS nodes.
- Identifying, analyzing, and evaluating strengths and weaknesses of each COA.
- Integrating targeting into the operation, to include identifying or confirming high-payoff targets and establishing attack guidance.
- Identifying hazards, assessing their risk, developing controls for them, and determining residual risk.

Wargaming Notes

CRITICAL EVENT: Aviation Deep Attack	
Sequence #	
Action	AVN BDE attacks to destroy enemy reserve on OBJ DEBRA
Reaction	Anti-air ambush in route
Counteraction	J/SEAD change air axis
Assets	1-78 FA (MLRS), 1-222 (AHB), Fixed-Wing
Time	H–2 to H + 1
Decision Point	DP 3b and 3c
CCIR	Location of enemy armor reserve south of PL Kansas
Control	Air Axis Falcon and Eagle
Remarks	

Figure 3-17. Sketch Note Work Sheet

Detail for one event

Task and Purpose

Actions by Friendly Forces

- Attack-by-Fire
- Breach
- Bypass
- Clear
- Consolidate and Reorganize
- Control
- Disengage
- Follow and Assume
- Follow and Support
- Linkup
- Occupy
- Reduce
- Retain
- Secure
- Seize
- Support by Fire

Effects on Enemy Forces

- Block
- Canalize
- Contain
- Defeat
- Destroy
- Disrupt
- Fix
- Interdict
- Isolate
- Neutralize
- Penetrate
- Turn

Figure 3-7. Mission Tasks

Conditions

- **<u>Conditions</u> are variables of the operational environment or situation that may affect performance.**

- <u>Environment</u> is the immediate situation or circumstance in which tasks must be performed.

- Conditions impact the ability to perform a task (e.g., security of lines of communication impact the ability to sustain joint task force operations).

Measures

Measures distinguish among varying levels of task performance. More than one measure may be specified for any single task.

Task:

OP 2.2.1 Collect Information on Operational Situation

Measures:

SCALE	MEASURE
Time	To retask collection asset
Time	Since most current intel. info. was collected
Percent	Of collection requirements filled
Percent	Of collection reqmts filled by multiple sources
Percent	Of targets accurately located
Percent	Of targets accurately identified

Standards

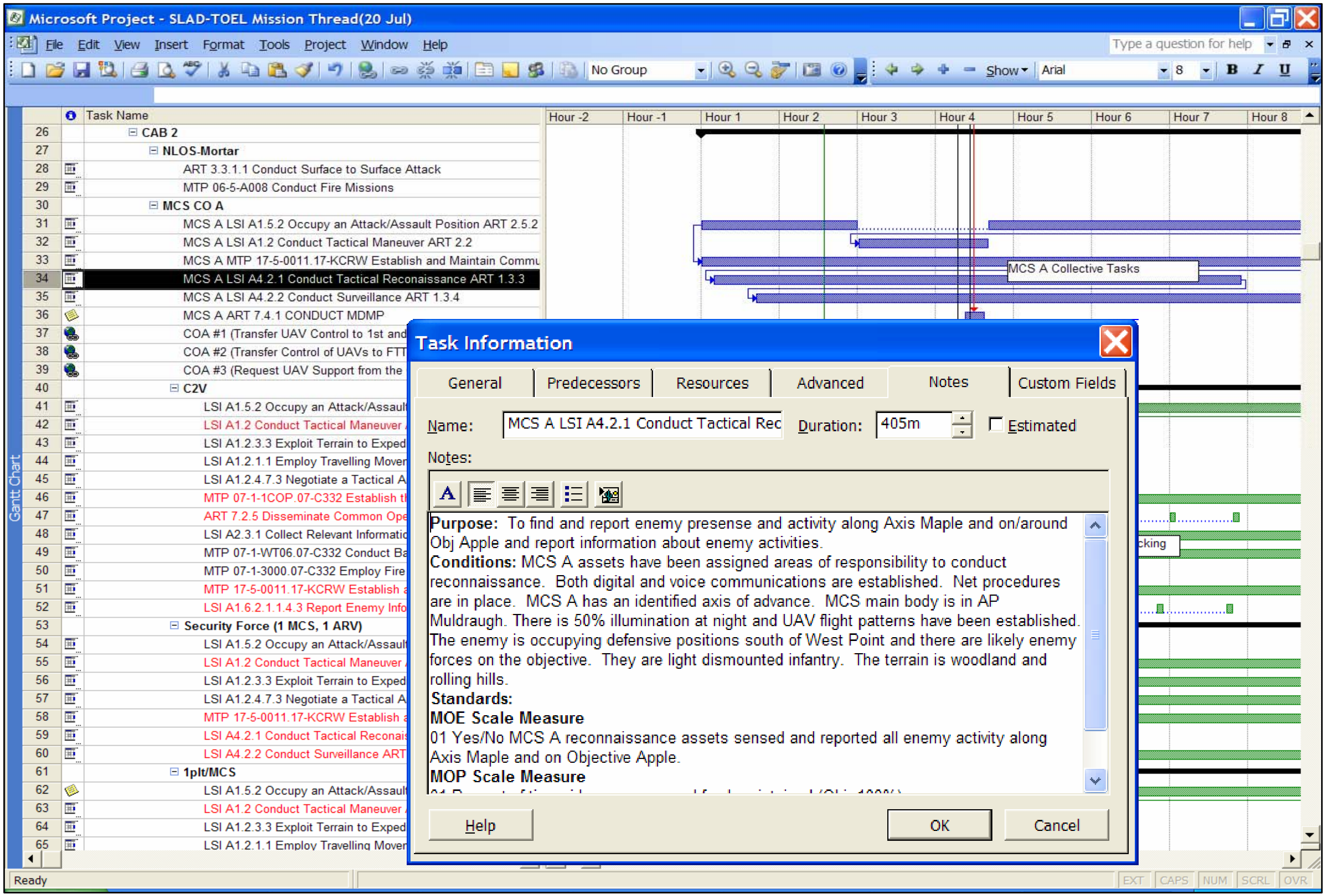
Standards express the degree to which (how well) a military organization or force must perform a task under a specified set of conditions.

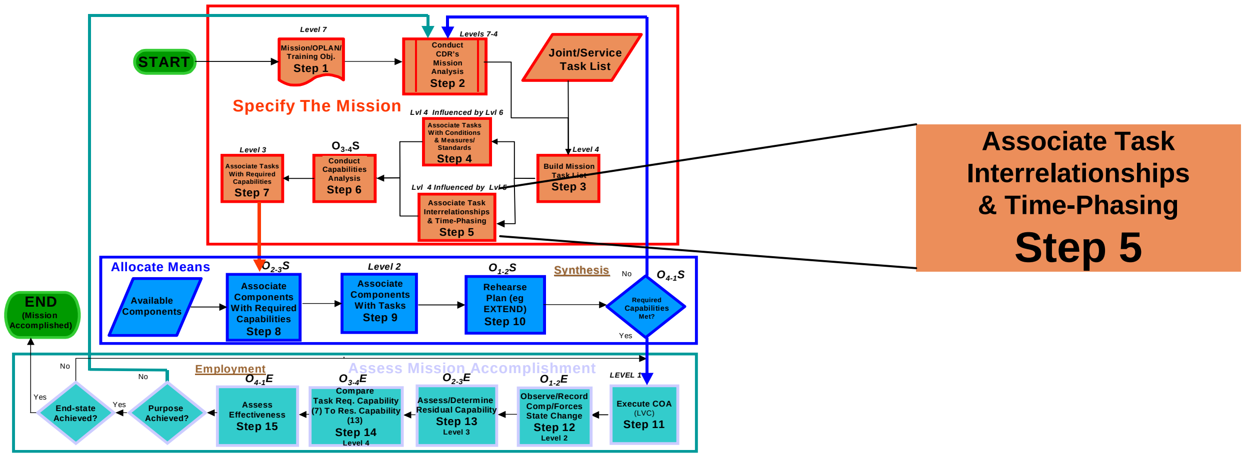
A criterion defines acceptable levels of performance for a measure and is often expressed as a minimum acceptable level of performance.

Standard:

Criterion	Scale	Measure
90	Percent	of collection requirements filled
4	Hours	since most current intelligence information was collected
85	Percent	of targets accurately located

MS Project Mission thread w/ notes page





- During the wargaming process, record the results of the wargaming process. We have done this using MS Project to build a mission file and:
  - Using MS Project functionality to capture task linkages and time phasing by:
    - Describing task attributes (continuous ((I.e. maintain COP)), iterative ((ie disseminate COP)), single instance ((ie. Conduct reconnaissance)).
    - Describing task dependencies by linking to predecessor and successor tasks.
    - Identifying and documenting parent and child tasks.
    - Describing task durations (known or estimated) and triggers.

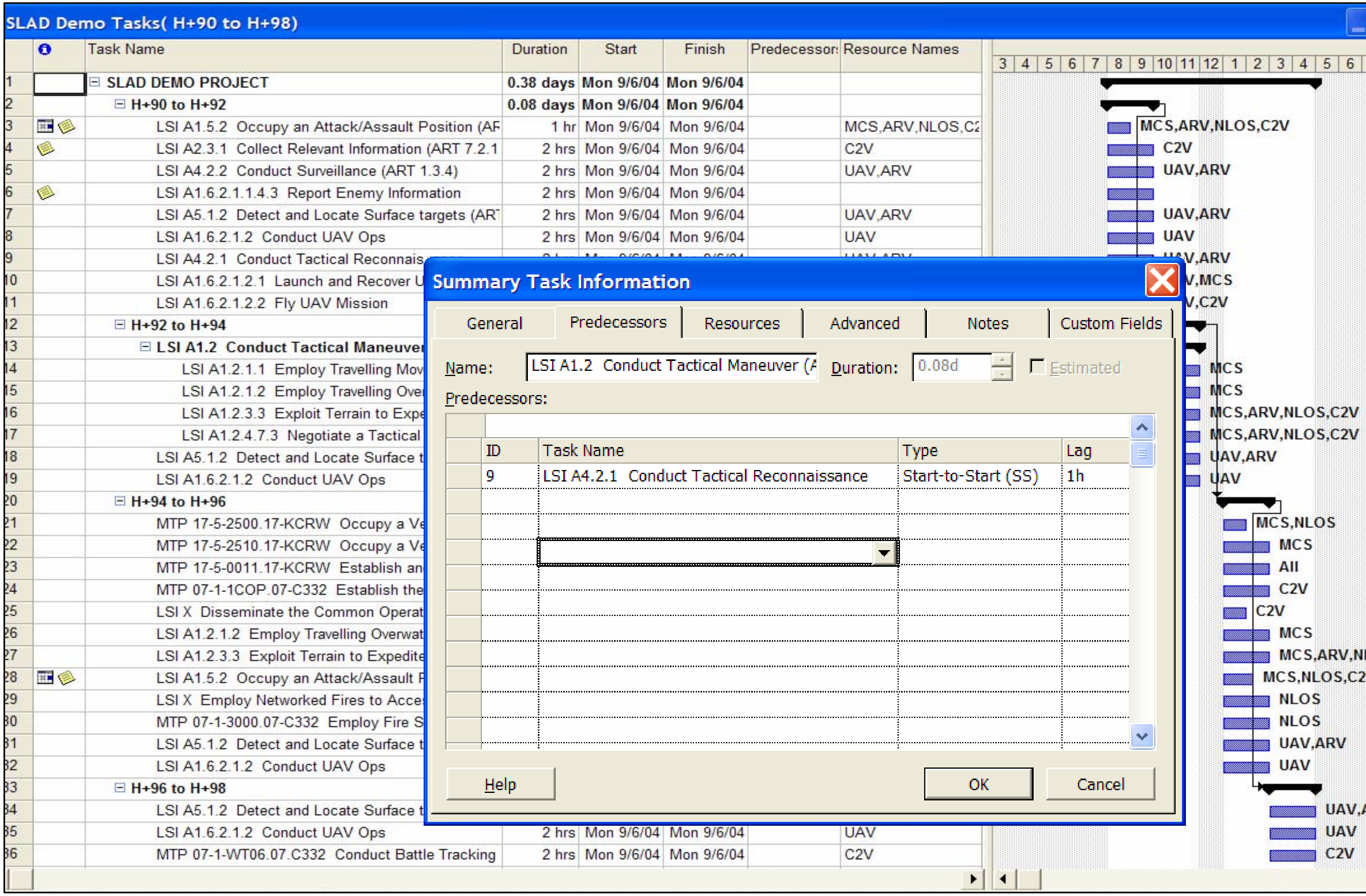
Sample Wargaming Output – Synch Matrix

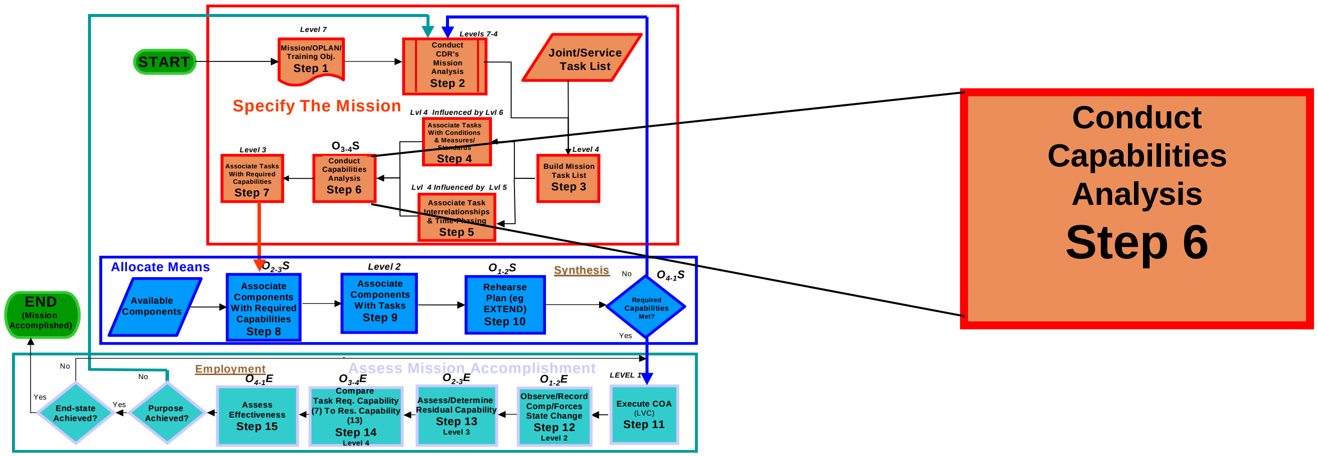
TIME/EVENT		H – 8	H – hour	H + 8
Enemy Action		Enemy Monitors Movements	Defends from Security Zone	Commits Reserve
Decision Points		Launch Deep Attack		
MANEUVER	1st Bde	Move on Route Paula	Cross LD	Seize on OBJ Nick
	2nd Bde	Move on Route Mike	Cross LD	Seize on OBJ Dave
	3rd Bde	Move on Route Sean		FPOL with 1st BDE
	Avn Bde	Deep Attack on OBJ Rose @ H - 1		
	Div Cav		Screen North Flank	
Air Defense		Weapons Hold		
Fire Support		Prep Fires Initiated at H - 5		
Information Operations		Surrender Broadcasts		Enemy C2 Jammed
M/C M/S		Route Maintained		
CSS		MSR Tampa Closed Southbound		
C2			TAC CP with Lead Bde	

NOTE: The first column is representative only and can be modified to fit unit needs.

Figure 3-16. Sample Synchronization Matrix Format

Recording Wargame results in Mission Thread





- Determine the type and level of functions and capabilities required to enable tasks to satisfy MOPs under the conditions identified
  - Primarily a cognitive process performed by SMEs applying logic, military judgment and experience
  - Function and Capability Descriptions vary, particularly when describing functions and capabilities of formations/organizations versus components/platforms (including people)
  - Requirements documents for Systems and Systems of Systems provide detailed description of functions and capabilities to be delivered (and tested)
  - Bottom-up execution and assessment portion of MMF requires ability to instantaneously compare “required” to “available” capability during execution of mission threads

Sample Cognitive Process for Determining Required Capabilities

Elements of Combat Power	Enemy strengths/ weaknesses	Friendly strengths/ weaknesses	Advantage	
			Friendly	Enemy
MANEUVER	Strength: Infantry with numerous anti-tank weapons. Weakness: Poorly maintained equipment. Lack of mobility between battle positions.	Strength: 3 X M1A2 equip combined arms task forces.	X	
FIREPOWER	Weakness: Limited to mortar fires.	Strength: Air supremacy, unopposed CAS, rocket and cannon fires.	X	
PROTECTION	Strength: Fully constructed defensive position with overhead cover.	Strength: Night vision capability; weapons standoff. Weakness: Soft skin vehicles and dismounted infantry.		X
LEADERSHIP	Strength: Elite unit very disciplined. Weakness: Lack of initiative by subordinates without orders from higher command.	Strength: Combat tested unit. Aggressive and offensive oriented command climate.	X	
INFORMATION	Strength: Full backing of local population and regional press. Weakness: C2 very acceptable to jamming and interception.	Strength: Secure and reliable C2 systems. Weakness: Seen as invaders and occupiers by opposing force and local population.		X

Figure 3-9. Sample Elements of Combat Power Analysis

Describing Levels of Capability – Degraded Capability Elements

C2V

NLOS
(6)

ARV-RISTA
(3)

Class-II UAV
(3)

Mobility

m_1 Reduced maximum speed
m_2 Reduced maneuverability
m_3 Stop after *t* min (leaks)
m_4 Total immobilization

Firepower

f_1 Lost ability to fire buttoned-up
f_2 Degraded delivery accuracy: main
f_3 Degraded initial rate of fire: main
f_4 Degraded subsequent rate of fire: main
f_5 Total loss of firepower: main

Target Acquisition

a_1 Lost daylight sights
a_2 Lost night sights

Surveillance & Reconnaissance

z_1 Lost primary sensor
z_2 Lost secondary sensor
z_3 Lost tertiary sensor
z_4 Lost vision blocks

Communication

x_1 Lost external data
x_2 Lost external voice
x_3 Lost internal comms
x_4 Lost LAN
x_5 Lost all comms

Survivability

s_1 Lost NBC protection
s_2 Lost ability to deploy obscurants
s_3 Lost silent-watch capability
s_4 Lost APS
s_5 Lost secondary armament

Crew

c_1 Commander incapacitated
c_2 Squad leader incapacitated
c_3 Driver incapacitated
c_4 Operator 1 incpacitated
c_5 Operator 2 incapacitated
c_6 Gunner incapacitated
c_7 Loader incapacitated

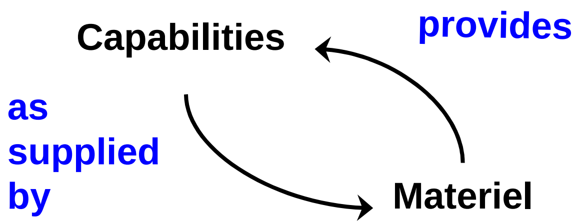
Other Mission Functions

o_1 Lost situational awareness

Catastrophic Loss

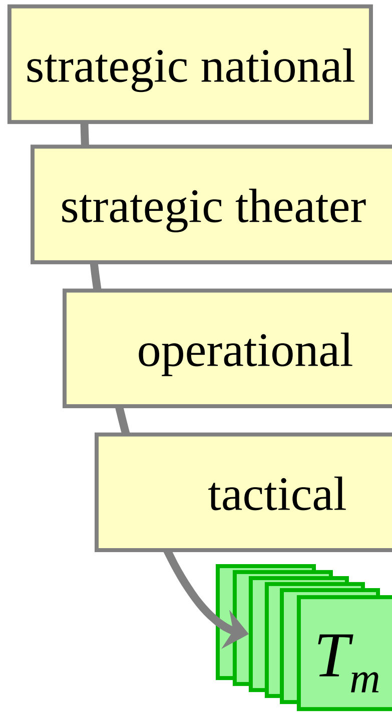
k_1 Lost every capability (fuel fire, ammo detonation, …)

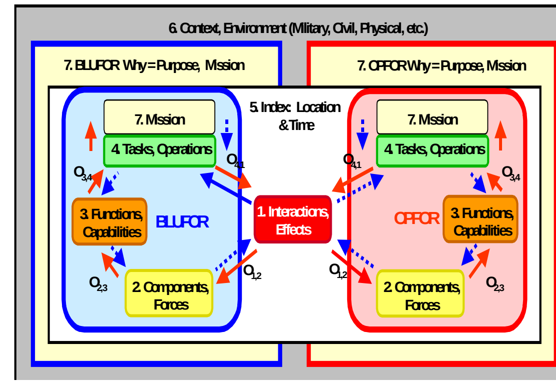
O&O Capabilities Mapped to Materiel via ORD & PCDs
(What materiel will be assessed to evaluate capability of interest?)

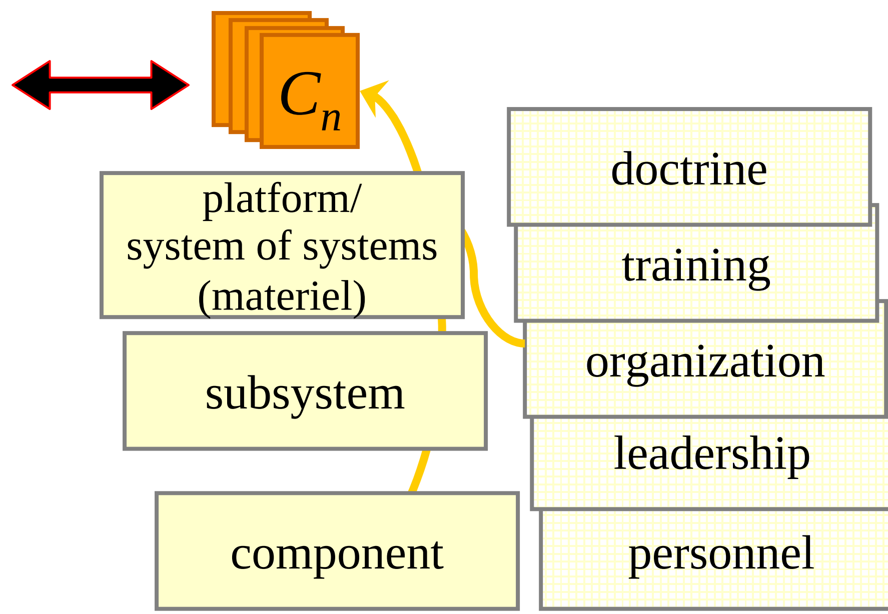


O&O Capability	ORD Reference #	Procurement Control Drawings (PCD)
F15: Enable continuous situational understanding through networked force	2392	786-300151
	2314	786-30093, Integrated Computers; 786-30143, Network Management
	2365	786-30093, Integrated Computers; 786-30143, Network Management; 786-30151
	2661	786-30018, Class III UAV; 786-30019, Class II UAV; 786-30020, Class I UAV; 786-30028; 786-30146, Situation Understanding (SU) SSS; 786-30151
	2869	786-30131, Tactical UGS System; 786-30132, Urban UGS System; 786-30144, C2 Battle Command & Mission Execution SSS; 786-30145, C2 Planning & Preparation SSS; 786-30151
F16: Facilitate automatic language translation	1040	786-30093, Integrated Computers
F17: Enable information exchange via adaptive, integrated communications	1016	786-300144, C2 Battle Command & Mission Execution SSS; 786-300145, C2 Planning & Preparation SSS; 786-300148; 786-300149, Warfighter Machine Interface (WMI); 786-300151; WIN-T; JTRS
	1120	786-30140, Ground Vehicle Communications; 786-30143, Network Management; 786-30149, Warfighter Machine Interface (WMI); 786-30151
	1148	786-30018, Class III UAV; 786-30019, Class II UAV; 786-30020, Class I UAV; 786-30022, Armed Robotic Vehicle (ARV); 786-30025, Small UGV (SUGV); 768-30093, Integrated Computers; 786-30151

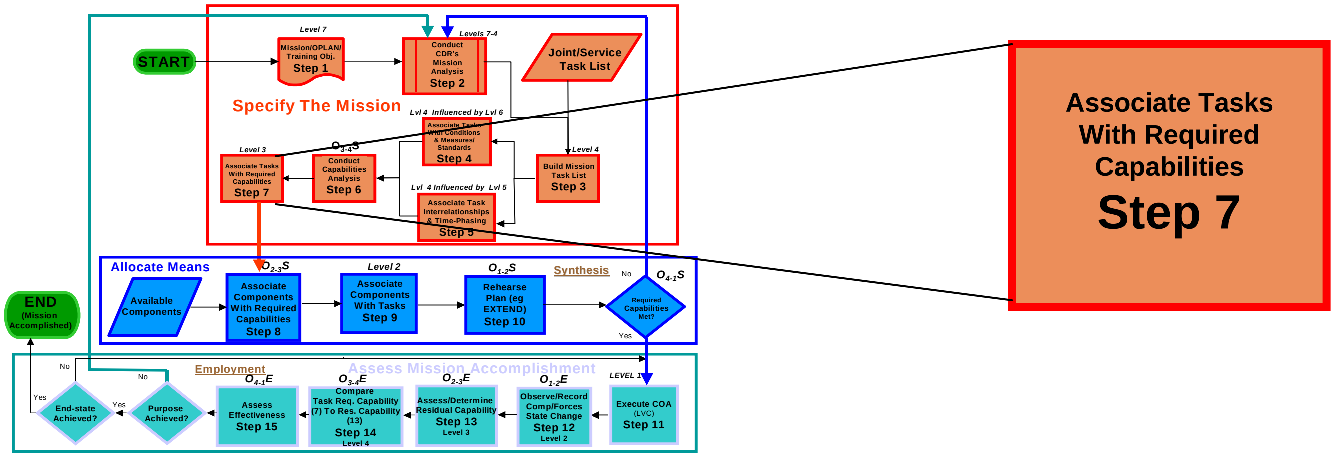
Comparing Required to Available







Is this a mission capability package
that meets
the mission capability requirement?

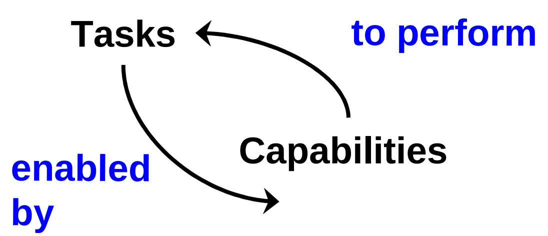


- From T&E perspective, this enables
  - Test and Evaluation planning to focus on activities that will most efficiently ensure ability to exercise, observe and assess capabilities
  - Ideally will be able to describe required capabilities in terms of:
    - MOPs and the associated capability categories for each task in a familiar and easily understood format for military users; and,
    - Unacceptable levels of capability degradation using capability elements in a familiar, easily understood and machine processable form for technical users.

Test and Evaluation Perspective --

(What must be done in a test to enable evaluation of capabilities?)

O&O Capabilities



TASK	AUTL Ref #	F12: Enable dissemination of tactical scheme	F15: Enable continuous situational understanding through networked force	F16: Facilitate automatic language translation	F17: Enable information exchange via adaptive, integrated communications	F18: Detect/prevent intruders/malicious software; identify points of intrusion/origin, information compromised/introduced into the network	F19: Enable Positional Navigation (POSNAV)	F20: Enable information management to fuse, monitor and disseminate information to support CCIR, combat action, decision-making and analysis	F21: Establish an adaptive learning repository to build and manage a library of friendly and enemy DTLOMS and lessons learned	F22: Enable terrain analysis	F23: Integrate synergistic use of ISR to see the full range of operational variables
Manage Tactical Information	ART 7.2		x	x	x	/		x			x
Process Relevant Information to Create a Common Operational Picture	ART 7.2.2		x	/	/	x	/	x	x	x	/
Display a Common Operational Picture (COP) Tailored to User Needs	ART 7.2.3	/	x	x	/	/		/			
ART 7.2.4 Store Relevant Information											
Disseminate COP and Execution Information to Higher, Lower, Adjacent, Supported, and Supporting Organizations	ART 7.2.5	x	x	/	x	/		/			/
ART 7.2.6 Communicate with Non-English Speaking Forces and Agencies											

Red with an X = Direct enabler of intent of task
Yellow with a / = Enables performing task to standard

Tasks ⇄ Capabilities: Linking it all Together

1	Lines from the TOEL											
2			TASKS	PLATFORM			Comms					
51	0200-1000	ART 7.2	*MTP 17-5-0011.17-KCRW Establish and Maintain Communications	ARV 2			x0		x2	x3	x4	
52	0412-0417	ART 7.2	*LSI A1.6.2.1.1.4.3 Report Enemy Information	ARV 2			x0		x2	x3	x4	
53	0200-1000	ART 7.2	*MTP 17-5-0011.17-KCRW Establish and Maintain Communications	ARV 3			x0		x2	x3	x4	
54	0757-0802	ART 7.2	*LSI A1.6.2.1.1.4.3 Report Enemy Information	ARV 3			x0		x2	x3	x4	
55	0200-1000	ART 7.2	*MTP 07-1-1COP.07-C332 Establish the Common Operational Picture	C2V			x0	x1	x2	x3	x4	x5
56	0200-0205, 0253-0258, 0308-0313, 0341-0346, 0437-0442, 0525-0530, 0633-0638, 0707-0712, 0800-0805, 0849-0854	ART 7.2	*ART 7.2.5 Disseminate Common Operational Picture and Execution Information	C2V			x0	x1	x2	x3	x4	x5
57	0200-1000	ART 7.2	LSI A2.3.1 Collect Relevant Information ART 7.2.1	C2V			x0	x1	x2	x3	x4	x5
58	0200-1000	ART 7.2	MTP 07-1-WT06.07-C332 Conduct Battle Tracking	C2V			x0	x1	x2	x3	x4	x5
59	0200-1000						x0	x1	x2	x3	x4	x5
60	0255-0300, 0339-0344, 0523-0528, 0706-0711, 0844-0849						x0	x1	x2	x3	x4	x5
61	0210-0542						x0	x1				
62	0250-0255, 030-0335						x0	x1				
63	0340-0835						x0	x1				
64	0431-0436						x0	x1				
65	0543-1000						x0	x1				

C2V

NLOS (6)

ARV-RISTA (3)

Class-II UAV (3)

Mobility
- m_1 Reduced maximum speed
- m_2 Reduced maneuverability
- m_3 Stop after t min (leaks)
- m_4 Total immobilization

Firepower
- f_1 Lost ability to fire buttoned-up
- f_2 Degraded delivery accuracy: main
- f_3 Degraded initial rate of fire: main
- f_4 Degraded subsequent rate of fire: main
- f_5 Total loss of firepower: main

Target Acquisition
- a_1 Lost daylight sights
- a_2 Lost night sights

Surveillance & Reconnaissance
- z_1 Lost primary sensor
- z_2 Lost secondary sensor
- z_3 Lost tertiary sensor
- z_4 Lost vision blocks

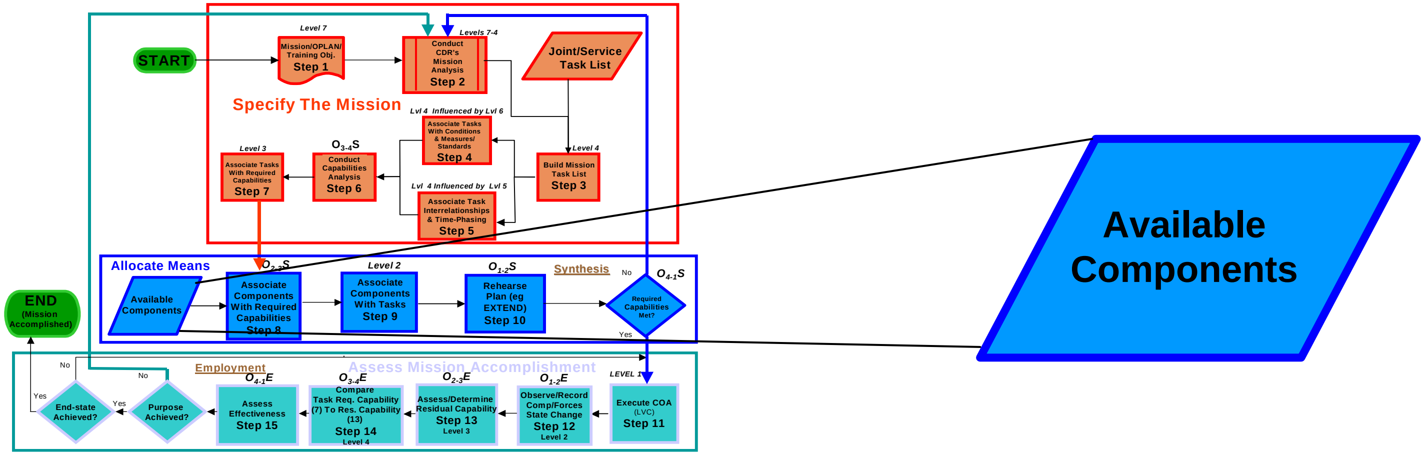
Communication
- x_1 Lost external data
- x_2 Lost external voice
- x_3 Lost internal comms
- x_4 Lost LAN
- x_5 Lost all comms

Survivability
- s_1 Lost NBC protection
- s_2 Lost ability to deploy obscurants
- s_3 Lost silent-watch capability
- s_4 Lost APS
- s_5 Lost secondary armament

Crew
- c_1 Commander incapacitated
- c_2 Squad leader incapacitated
- c_3 Driver incapacitated
- c_4 Operator 1 incpacitated
- c_5 Operator 2 incapacitated
- c_6 Gunner incapacitated
- c_7 Loader incapacitated

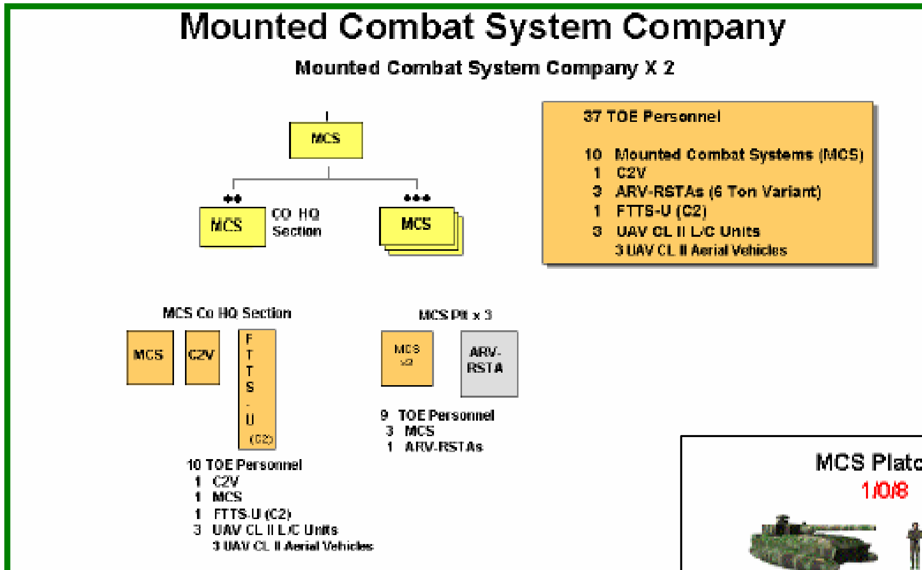
Other Mission Functions
- o_1 Lost situational awareness

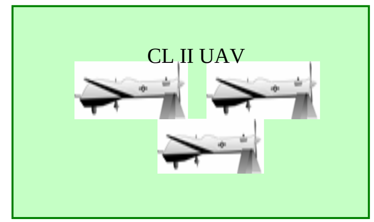
Catastrophic Loss
- k_1 Lost every capability (fuel fire, ammo detonation, ...)

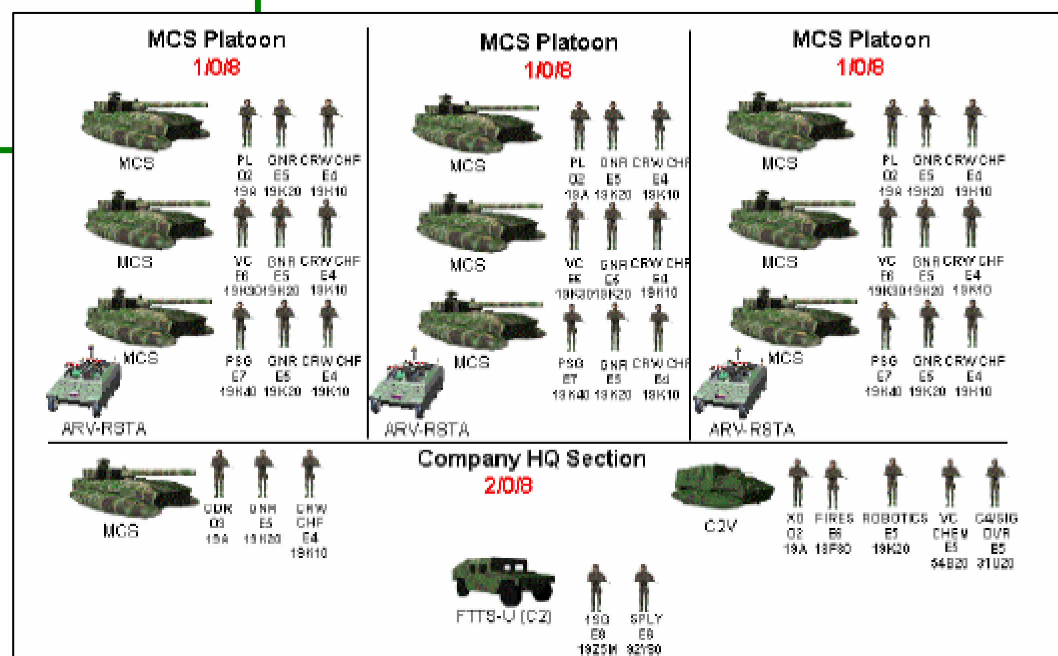


- Determine forces and associated MTOE type data that are to be included in the test.
    - Test Objectives and nature of the test (i.e. DT, OT, etc.) or test event may drive determination.
    - Use available source documents (i.e., ORD, O&O, Systems Book, etc.) to understand organization and platform required capabilities, limitations, intended use, etc. Incorporate this information into wargaming and determination of task MOPs.
    - ARL-SLAD used the documentation above and other technical documentation to generate or select substitute platform (i.e. Stryker, Paladin, etc.) tables of capability categories and degraded capability elements to support analysis of platforms to be modeled

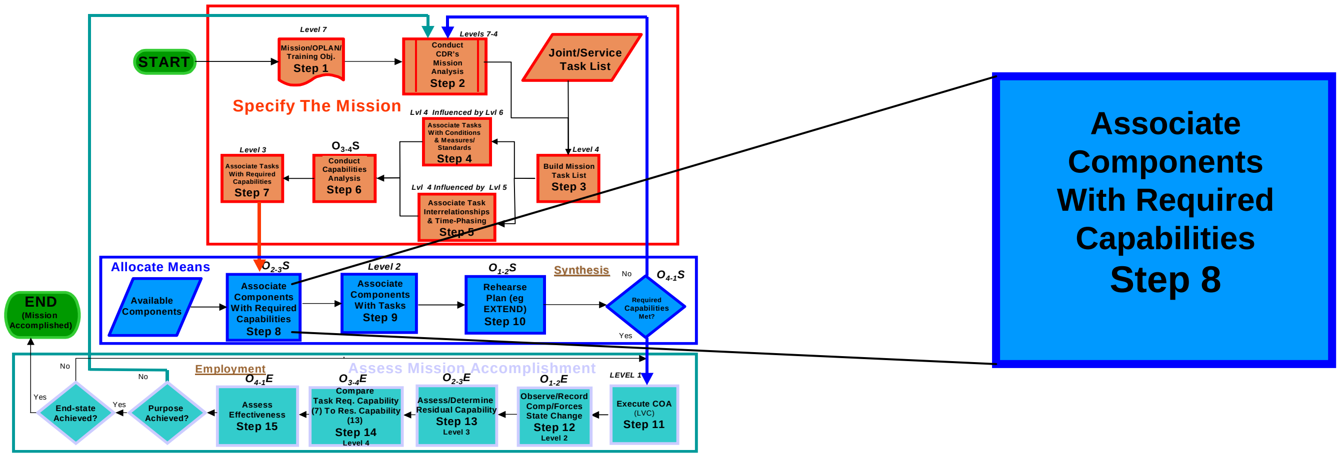
MCS A Company Organization





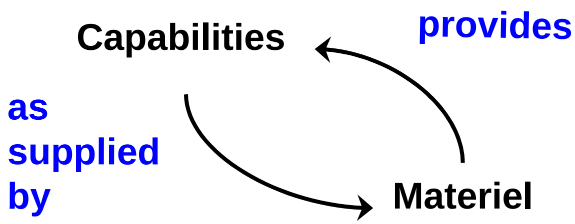


TRADOC PAM 525-3-90
Maneuver O & O, June 2003



- From T&E perspective this will normally be provided in Requirements Documentation
- Can be a challenge to pull together data for current systems and forces
- Especially challenging to gather data for degraded capability caused by changes in systems and forces

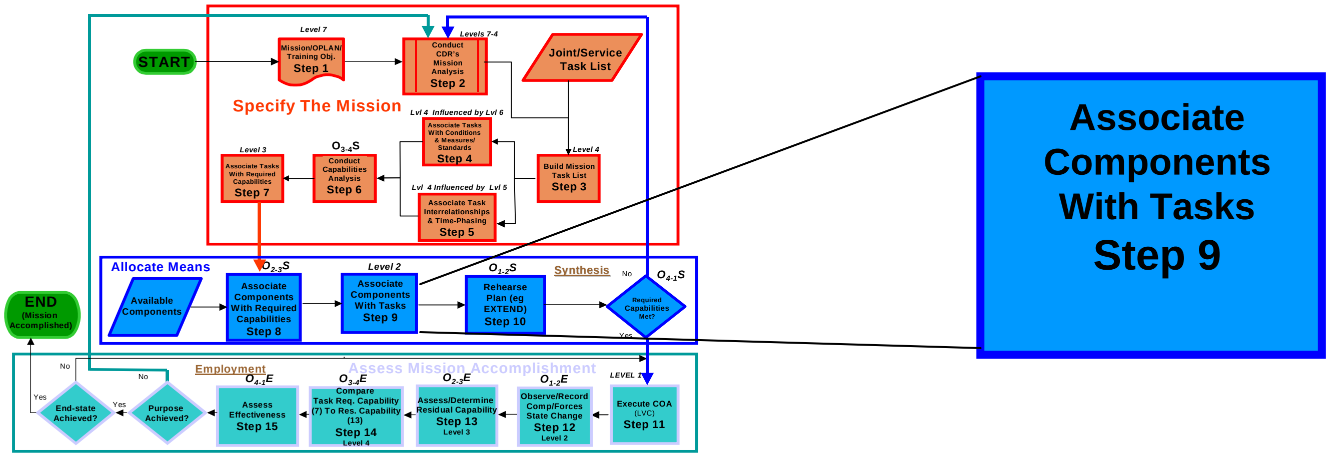
Testing and Evaluation Perspective --
(What materiel will be assessed to evaluate capability of interest?)



O&O Capability	ORD Reference #	Procurement Control Drawings (PCD)
F15: Enable continuous situational understanding through networked force	2392	786-300151
	2314	786-30093, Integrated Computers; 786-30143, Network Management
	2365	786-30093, Integrated Computers; 786-30143, Network Management; 786-30151
	2661	786-30018, Class III UAV; 786-30019, Class II UAV; 786-30020, Class I UAV; 786-30028; 786-30146, Situation Understanding (SU) SSS; 786-30151
	2869	786-30131, Tactical UGS System; 786-30132, Urban UGS System; 786-30144, C2 Battle Command & Mission Execution SSS; 786-30145, C2 Planning & Preparation SSS; 786-30151
F16: Facilitate automatic language translation	1040	786-30093, Integrated Computers
F17: Enable information exchange via adaptive, integrated communications	1016	786-300144, C2 Battle Command & Mission Execution SSS; 786-300145, C2 Planning & Preparation SSS; 786-300148; 786-300149, Warfighter Machine Interface (WMI); 786-300151; WIN-T; JTRS
	1120	786-30140, Ground Vehicle Communications; 786-30143, Network Management; 786-30149, Warfighter Machine Interface (WMI); 786-30151
	1148	786-30018, Class III UAV; 786-30019, Class II UAV; 786-30020, Class I UAV; 786-30022, Armed Robotic Vehicle (ARV); 786-30025, Small UGV (SUGV); 768-30093, Integrated Computers; 786-30151

Matching Components to Required Capabilities

Capability Category / Platform	MOBILITY	FIREPOWER	COMMUNICATIONS	SURVIVABILITY	TARGET ACQUISITION	SURVEILLANCE
	A quality or capability of military forces which permits them to move from place to place while retaining the ability to fulfill their primary mission.	The amount of fire which may be delivered by a position, unit, or weapon system. 2. Ability to deliver fire.	The means or method to convey information of any kind from one person or place to another.	Concept which includes all aspects of protecting personnel, weapons, and supplies while simultaneously deceiving the enemy. Survivability tactics include building a good defense; employing frequent movement; using concealment, deception, and camouflage; and constructing fighting and protective positions for both individuals and equipment.	The detection, identification, and location of a target in sufficient detail to permit the effective employment of weapons.	The systematic observation of aerospace, surface, or subsurface areas, places, persons, or things, by visual, aural, electronic, photographic, or other means.
AIRCRAFT						
Rotary Wing	x	x	x	x	x	
Fixed Wing	x		x	x	x	
UAVs	x	x	x	x	x	x
Air Traffic Control Systems			x	x		x
Aircraft Rockets	x	x			x	
AIR DEFENSE SYSTEMS	x	x	x	x	x	
ANTIARMOR WEAPONS	x	x		x	x	
C4I SYSTEMS						
Digital Battle Command			x			
C4 Support to Air & Missile Defense			x		x	x
C4 Support to Network Operations			x			
C4 Support to Intelligence Operations			x		x	x
Sensor / Sensor Systems	x			x	x	x
Night Vision Sensors			x	x	x	x
Aircraft Survivability Equipment				x		
Radios & Communication Systems			x	x		
ENGINEER & COUNTERMINE EQUIPMENT						
Engineer Equipment	x		x	x		



- From T&E perspective, the O&O plan and follow on documentation such as Operational Mode Summary – Mission Statements will provide the association for specific mission sets

- This information is useful for constructing mission threads and TOELs for use in test events and for tying together discrete test events (i.e. live fire or developmental tests) being performed as part of a larger, distributed test construct.

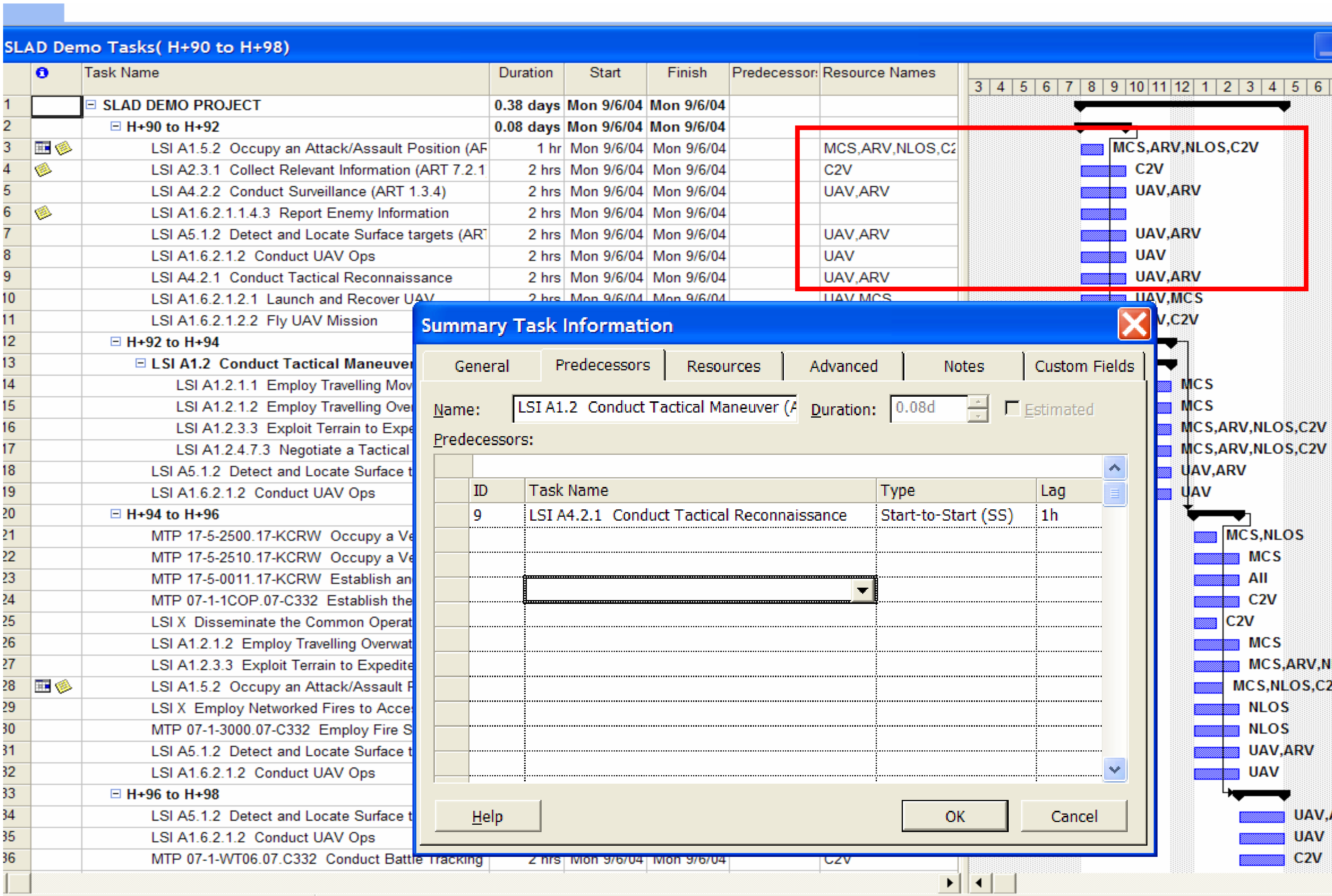
Matching Components (Platforms and Units) to Tasks – Task Organize

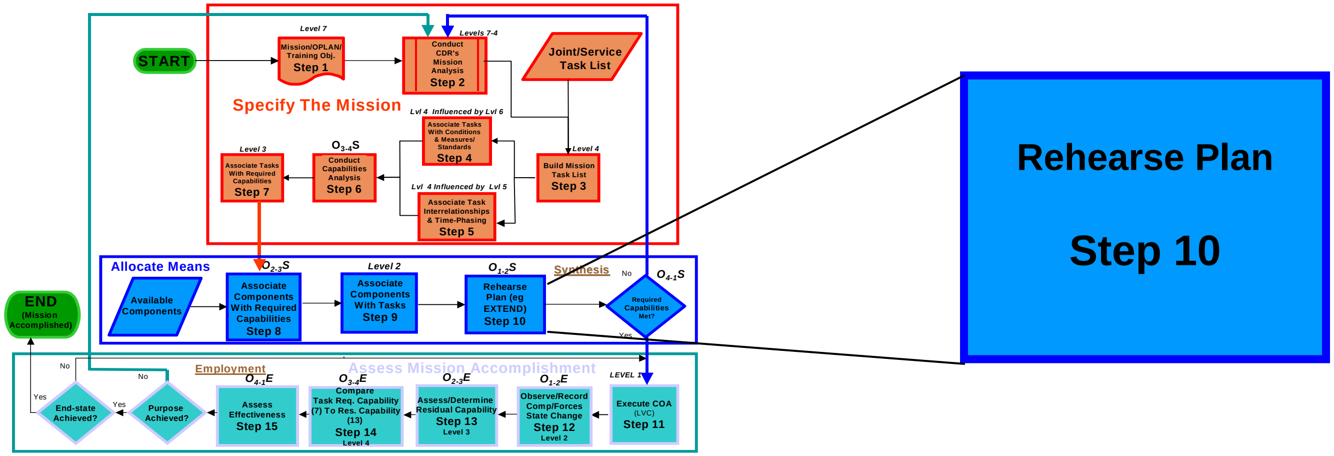
M91 = x

A	E	F	G	H	I	J	M
AUTL / PLATFORM	Tactical UAV	Large FW UAV	VTOL UAV		M1A2	M60	M113 A3
Link to Equipment Data Sheet	UAV Shadow 200	Predator UAV	UAV A160 Hummingbird		M1A2	M60 Tank	M113
Chapter 1 ART 1.0: The Intelligence Battlefield Operating System							
SECTION I ART 1.1: SUPPORT TO SITUATIONAL UNDERSTANDING	X	X	X				
ART 1.3.3 CONDUCT TACTICAL RECONNAISSANCE	X	X			X		X
ART 1.3.3.1 CONDUCT A ZONE RECONNAISSANCE	X	X			X		X
ART 1.3.3.2 CONDUCT AN AREA RECONNAISSANCE	X	X			X		X
ART 1.3.3.3 CONDUCT A RECONNAISSANCE-IN-FORCE					X		X
ART 1.3.3.4 CONDUCT A ROUTE RECONNAISSANCE	X	X			X		X
ART 1.3.3.5 CONDUCT A RECONNAISSANCE PATROL					X		X
ART 1.3.4 CONDUCT SURVEILLANCE	X	X	X		X		X
Chapter 2 ART 2.0: The Maneuver Battlefield Operating System							
ART 2.2.2 CONDUCT ACTIONS ON CONTACT					X		X
ART 2.2.3 EMPLOY COMBAT PATROLS					X		X
ART 2.2.4 CONDUCT COUNTERAMBUSH ACTIONS					X		X
ART 2.2.5 EXPLOIT TERRAIN TO EXPEDITE TACTICAL MOVEMENTS					X		X

Priority Matrix / TOT AUTL & All PLATFORMS / AUTL IND Tsks & All PEs / All IND Tsks & M113 DCS / M113 IND Tasks & DCS / ALL PLATFORMS

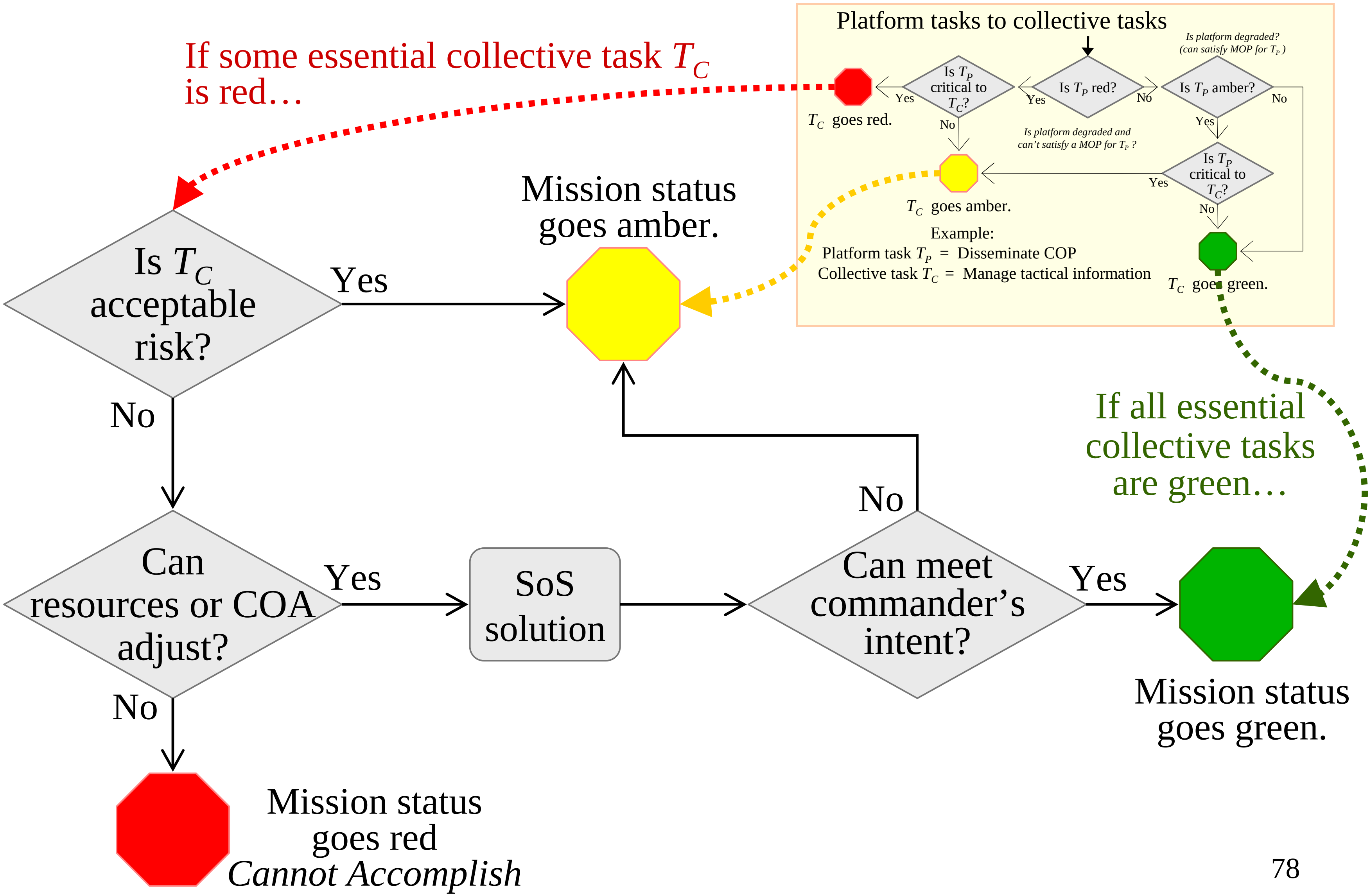
Matching Components to Tasks





- Test completed mission threads in a live, virtual, constructive, or combination environment. For example, DRC and Northrop-Grumman SMEs worked together to develop a “what if” simulation model, built using the EXTEND tool, that used products developed during steps 1-9 along with a Decision Making Process flow chart to execute the following processes:
  - Event generation
  - Component, Sub-system, Capability State changes
  - Determine platform task status, collective task status, mission task status
- And produce the following displays and outputs:
  - Current platform capability
  - Current platform task ability
  - Current collective task status
  - Current mission assessment status
  - Record of state changes, task status changes, mission health status changes

Decision Making Process Flow Chart



EXTEND Tool Use to Construct Mission and Means Capability Degradation Model (M2CDM) to:

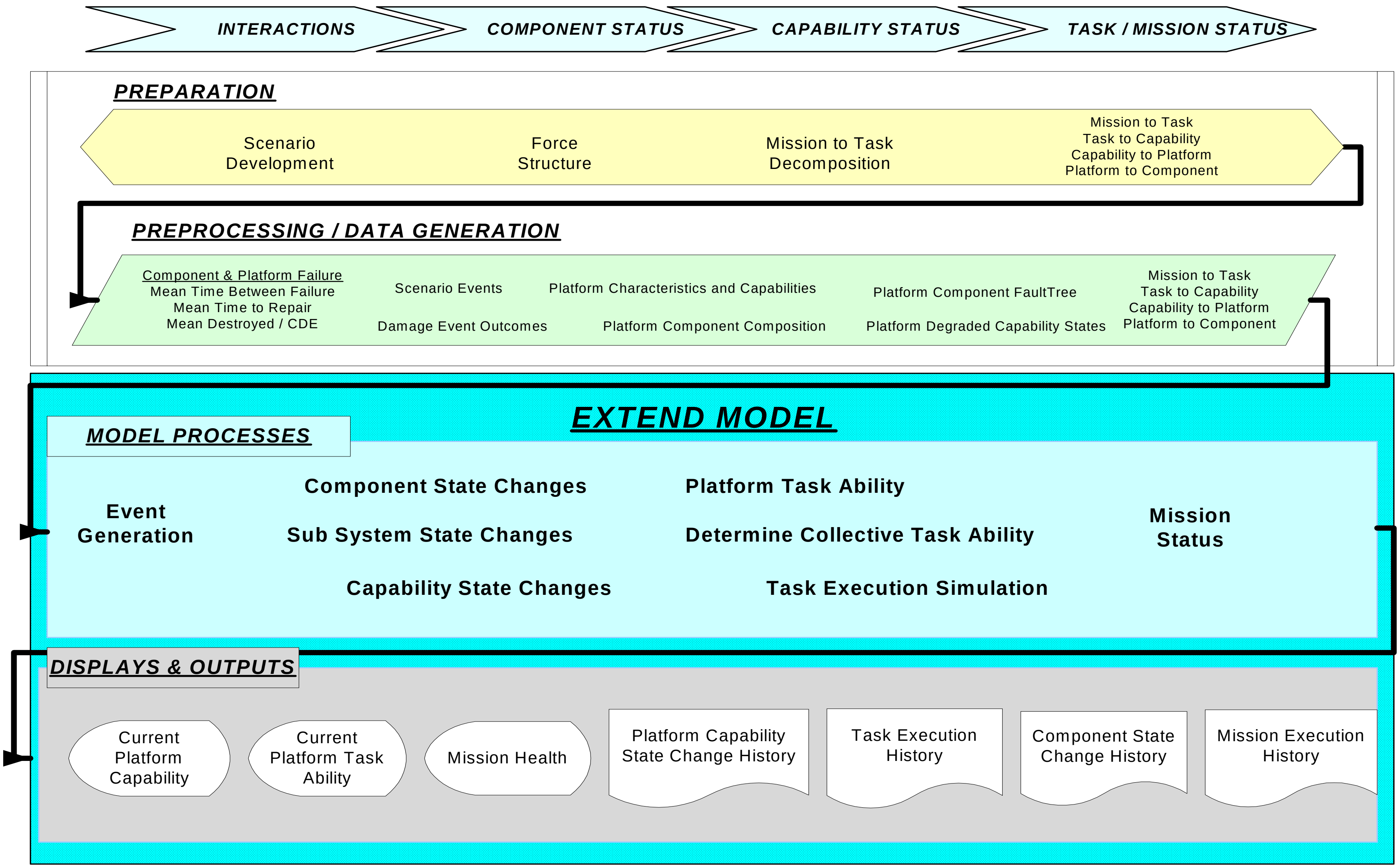
- Map component-level state changes to platform level capabilities
- Map platform level capabilities to ability to perform tasks
- Map ability to perform tasks to mission success

Initialization data requirements for M2CDM

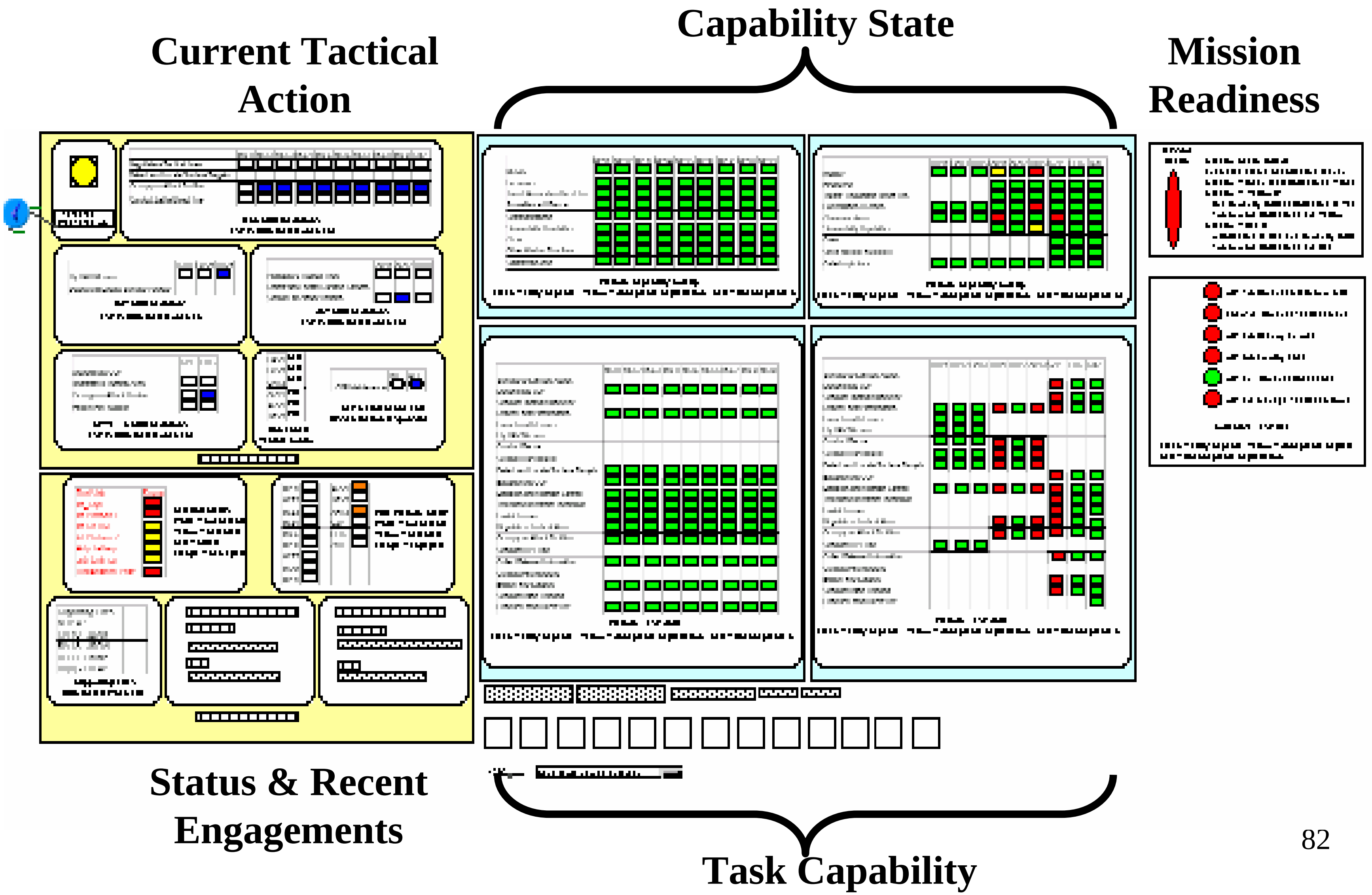
- Tactical Scenario
- Military Organizations and Equipment
- Important Data Elements
  - Platform to Task Relationships
  - Sequence of Events
  - Effect of Component Loss on Platform Capability
  - Effect of Degraded Capability on Task Accomplishment

TOP LEVEL FLOWCHART
MMF PROOF OF CONCEPT MODEL

MODEL PURPOSE: ***Does the Mission Capability Package Meet the Mission Capability Requirement?***



Missions and Means Degraded Capabilities Model (M2DCM)



Mission Readiness

Mission Health

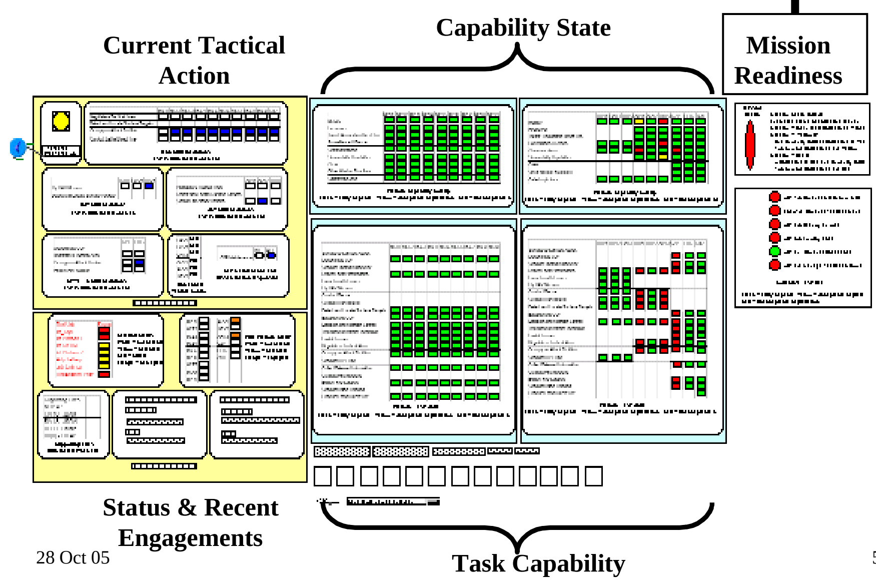
Mission Health Criteria
Evaluates status of collective tasks.
Mission = Green if all Collectives = Green
Mission = Yellow if:
  One Currently Critical Collective is Yellow, or
  Two or more Collectives are Yellow
Mission = Red if
  A Collective is Red and Currently Critical
  Two or more Collectives are Red

ART 1.3 Conduct Intell, Surv & Recce)
LSI A1.2 Conduct Tactical Maneuver
ART 2.5 Occupy an Area
ART 3.3 Employ Fires
ART 2.4 Conduct Direct Fires
ART 7.2 Manage Tactical Information

Collective Task Health

Green = Fully Capable Yellow = Acceptable Degradatio
Red = Unacceptable Degradation

Missions and Means
Degraded Capabilities Model (M2DCM)



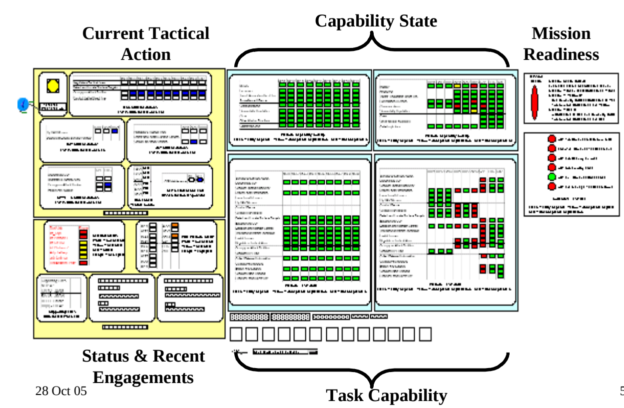
Capability State

	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9
Mobility									
Firepower									
Target Acquisition Direct Fire									
Surveillance & Recce									
Communications									
Survivability Capabilities									
Crew									
Other Mission Functions									
Catastropic loss									

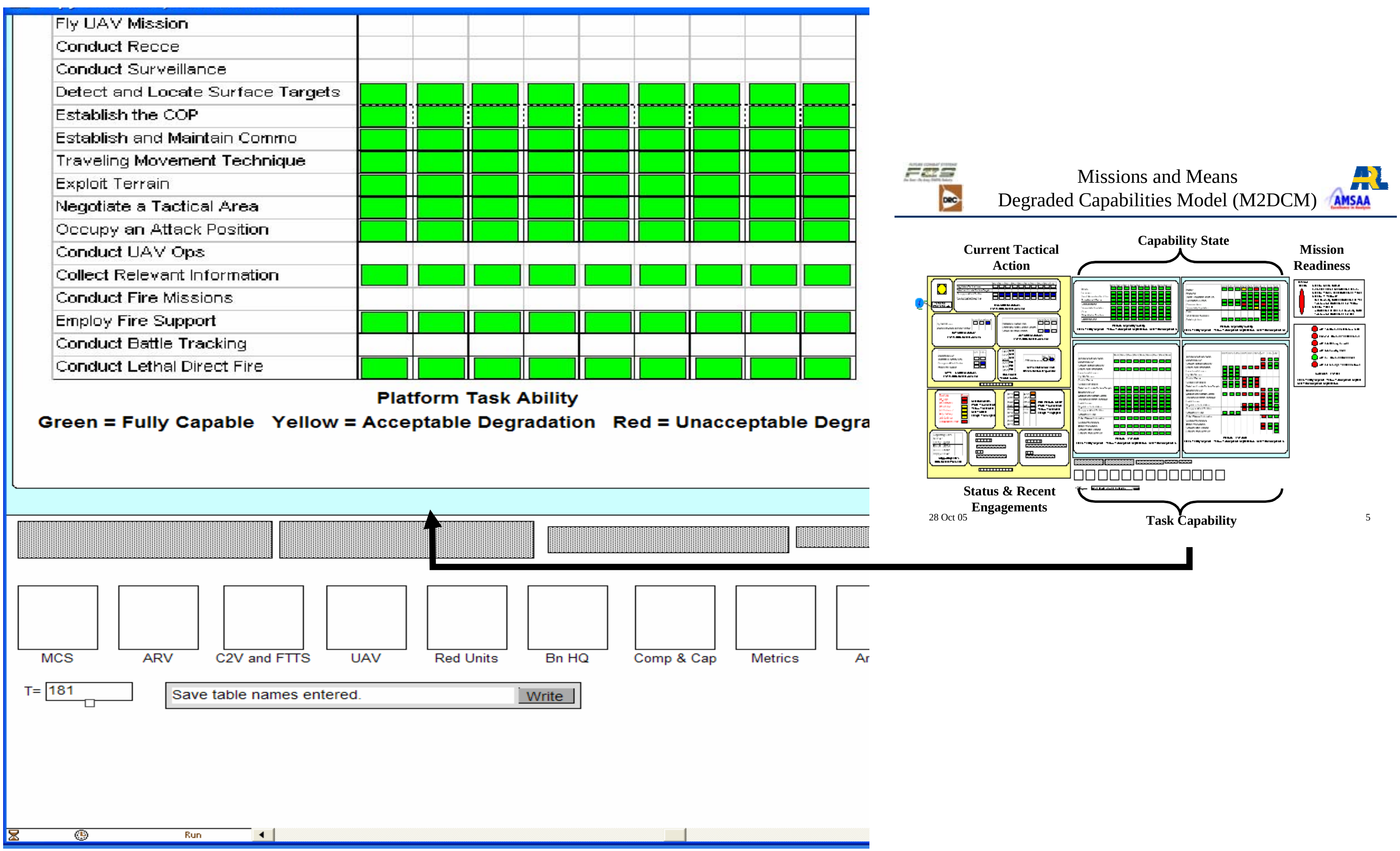
Platform Capability Roll Up

Green = Fully Capable   Yellow = Acceptable Degradation   Red = Unacceptable Degrada

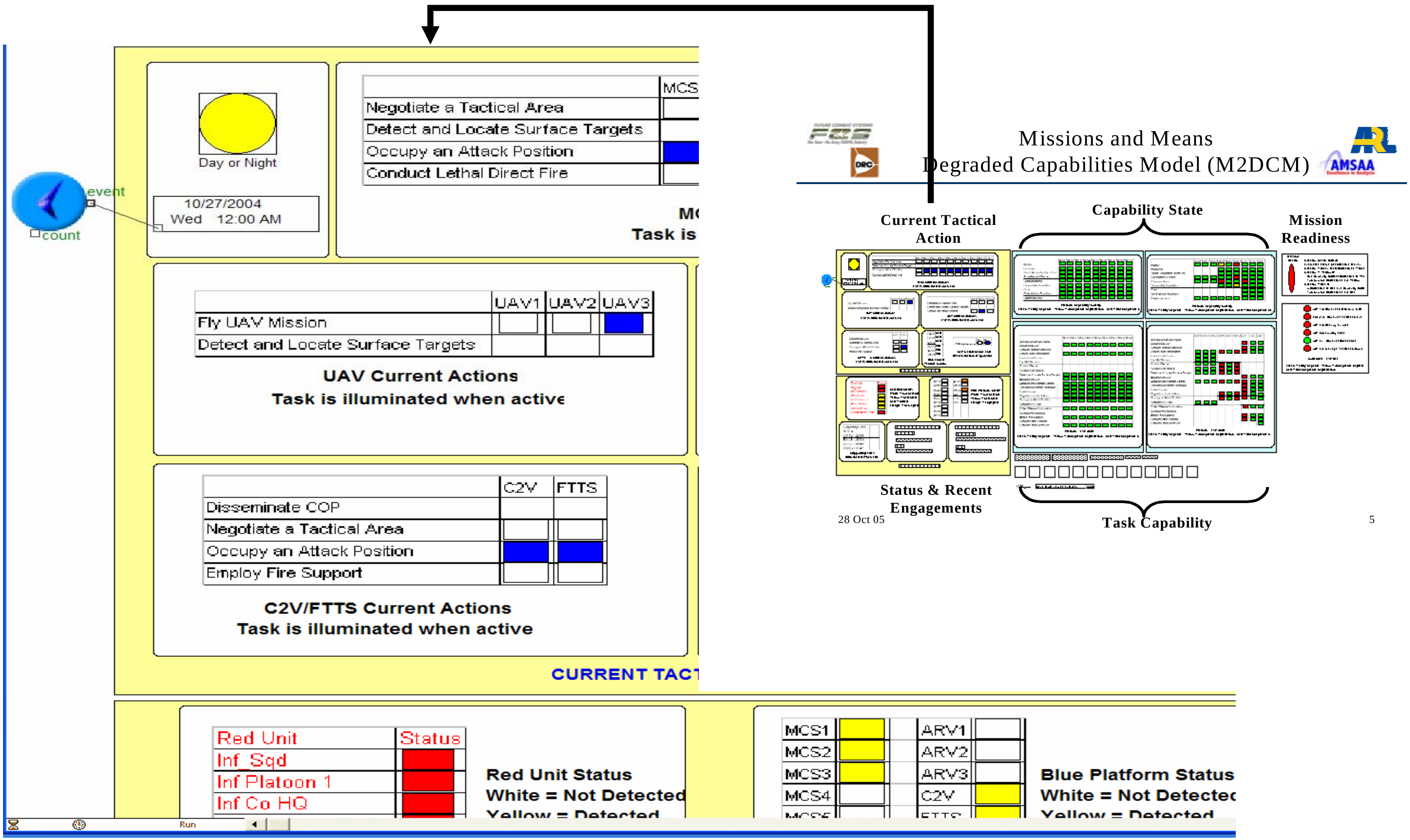
	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9
Surface to Surface Attack									
Disseminate COP									
Conduct Tactical Maneuver									
Report Enemy Information									
Launch and Recover									
Fly UAV Mission									
Conduct Recce									
Conduct Surveillance									
Detect and Locate Surface Targets									
Establish the COP									
Establish and Maintain Commo									
Traveling Movement Technique									
Exploit Terrain									
Negotiate a Tactical Area									



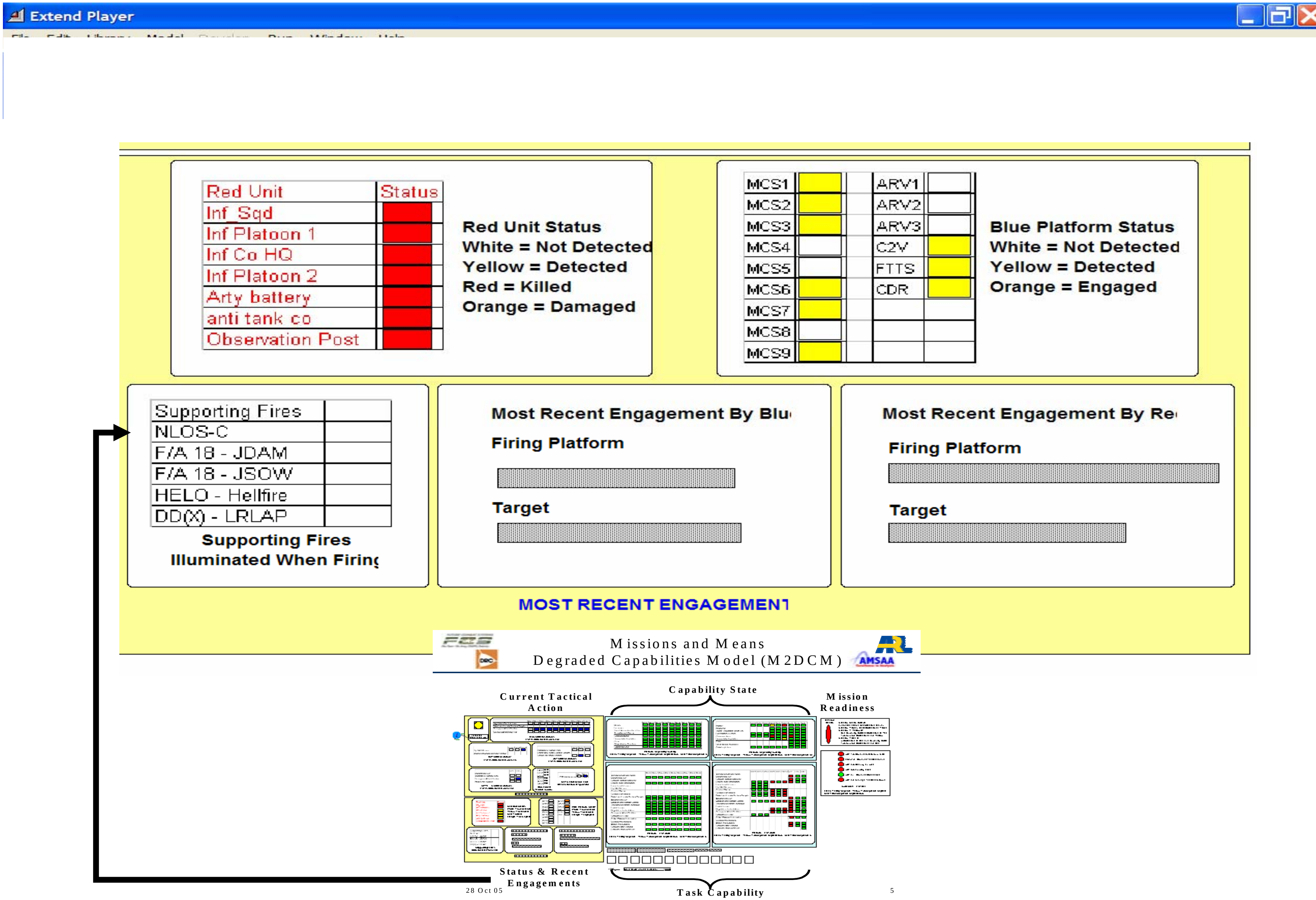
Task Capability



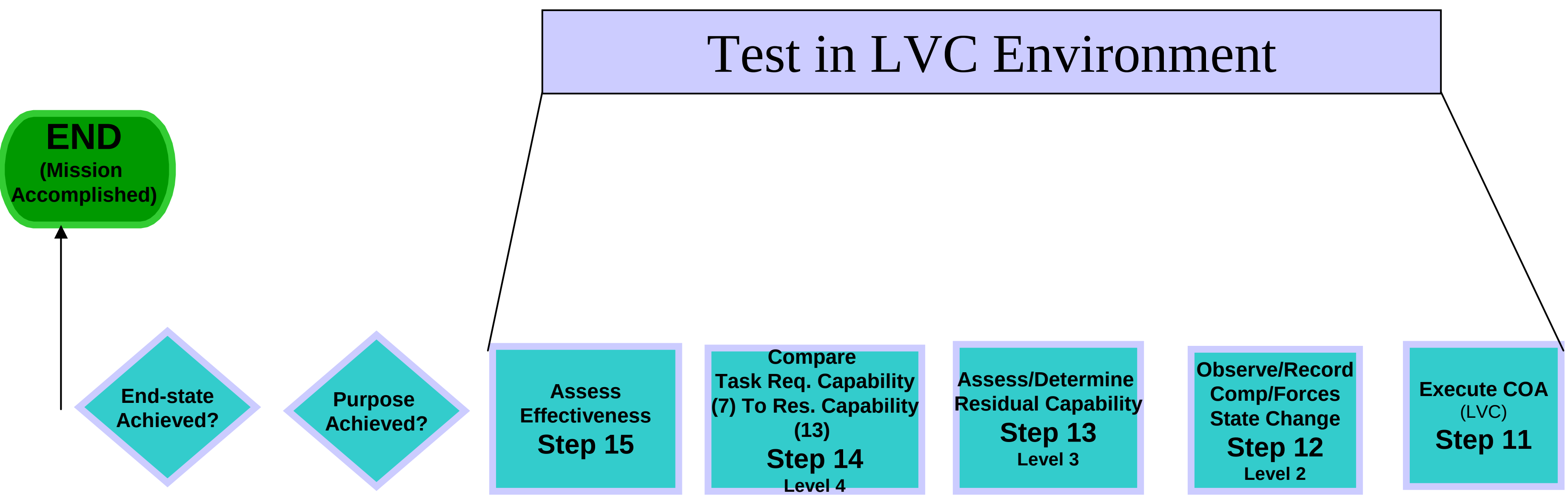
Current Tactical Action



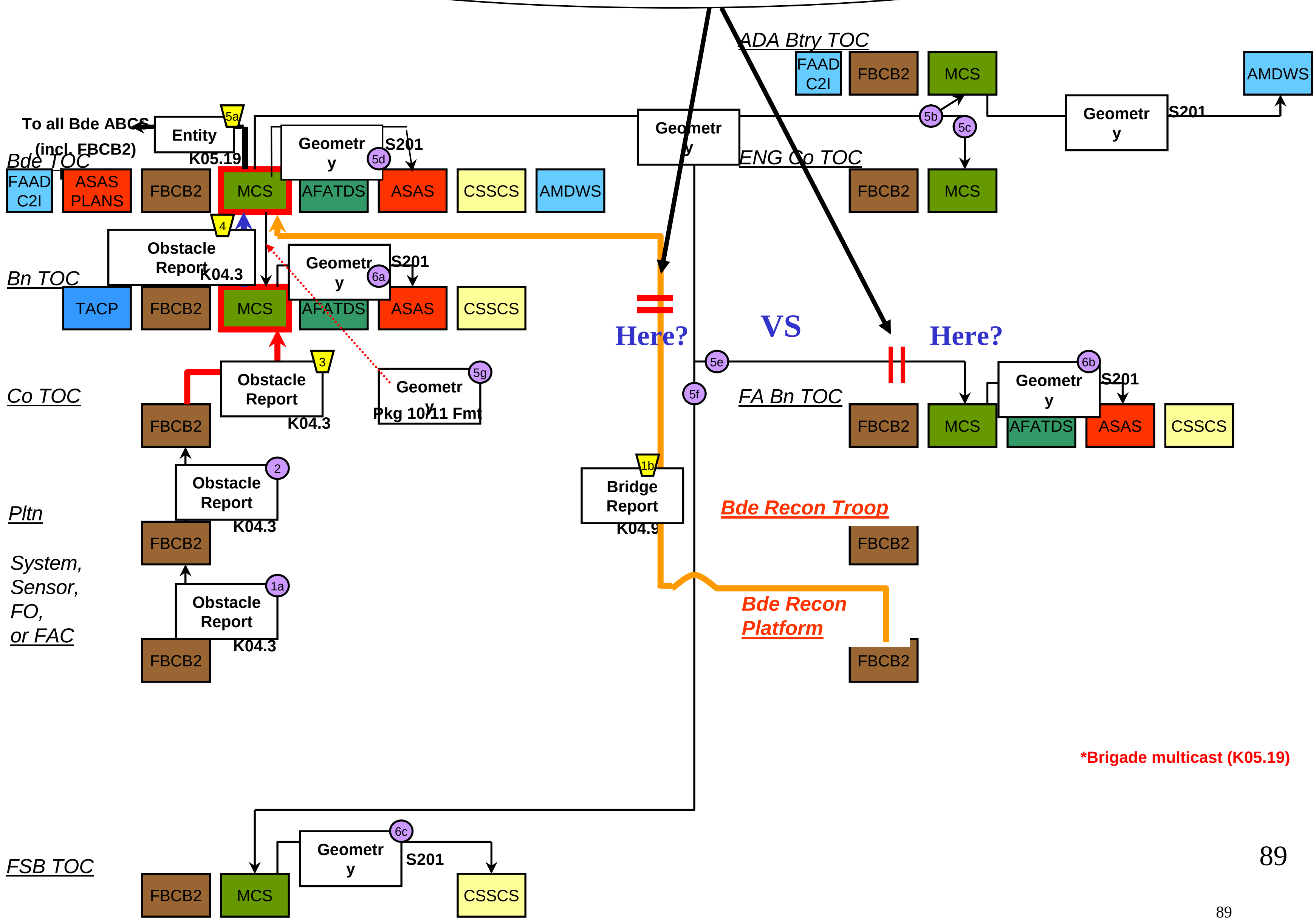
Status & Recent Engagements



- Application of the previous ten steps of the process results in sufficiently rigorous specification of the mission to gain meaningful data from execution in LVC environment
- This is particularly useful for evaluating Effectiveness, Suitability and Survivability
- Challenge is finding the appropriate execution environment that provides a sufficient level of granularity and fidelity to permit observation, evaluation and assessment of tasks against MOEs and MOPs. Execution plan may drive requirements for models and simulations not currently available

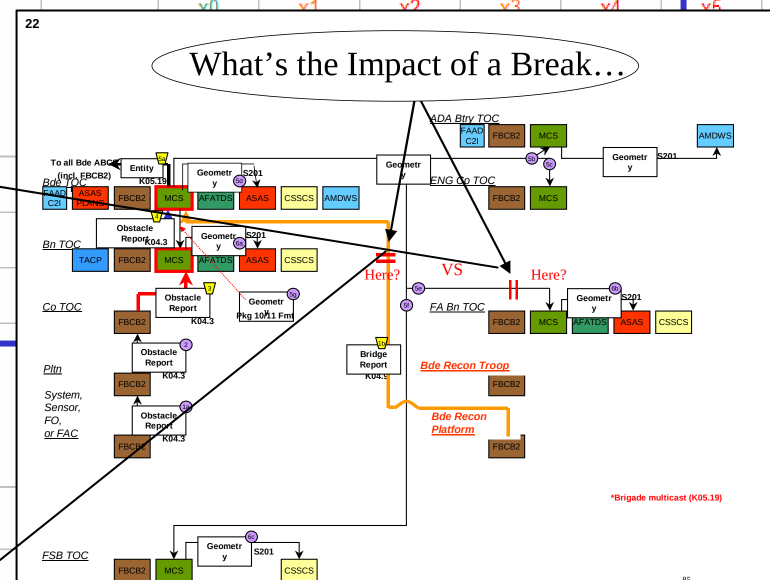


What's the Impact of a Break…

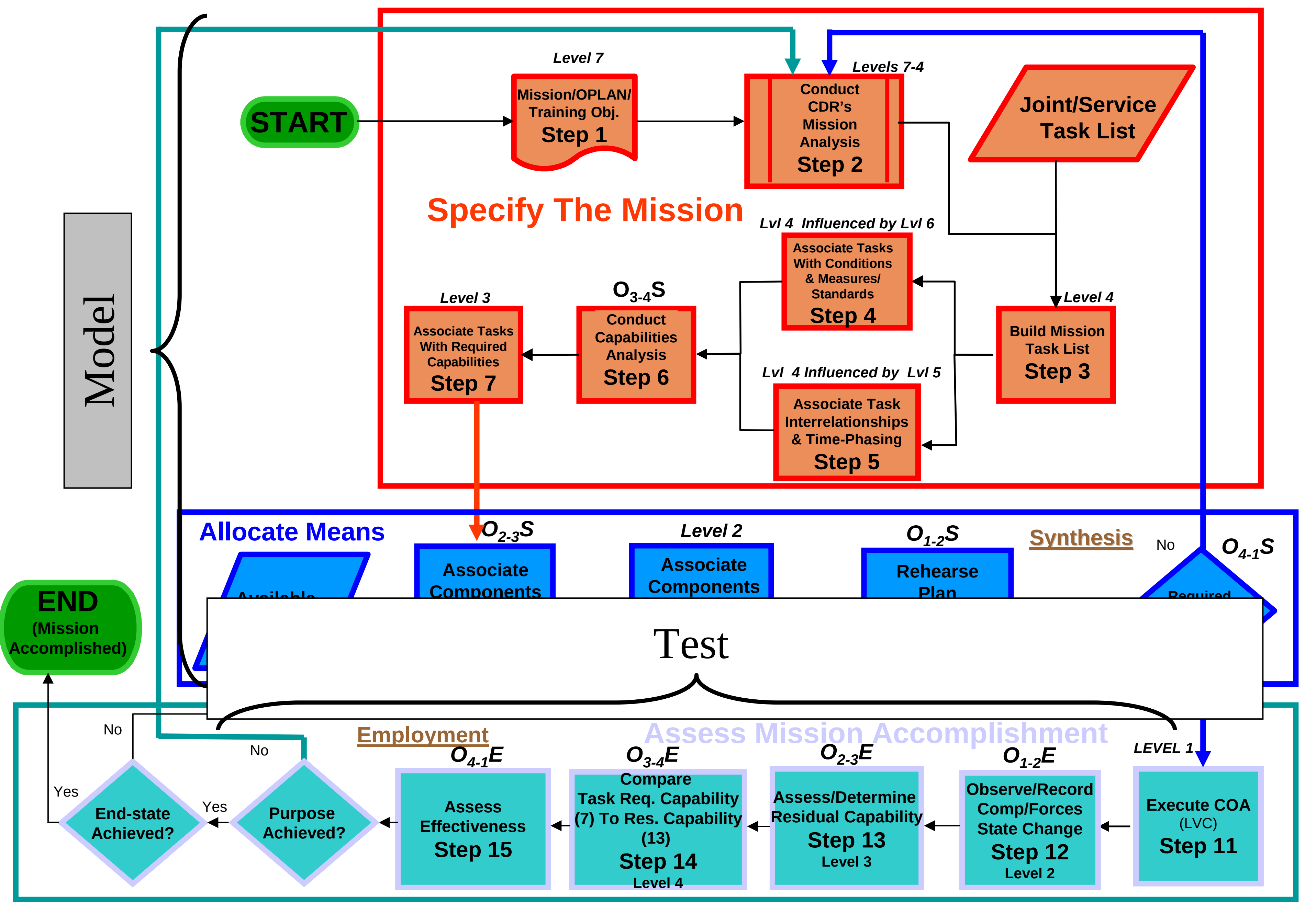


Lines from the TOEL											
		TASKS	PLATFORM			Comms					
0200-1000	ART 7.2	*MTP 17-5-0011.17-KCRW Establish and Maintain Communications	ARV 2			x0		x2	x3	x4	
0412-0417	ART 7.2	*LSI A1.6.2.1.1.4.3 Report Enemy Information	ARV 2			x0		x2	x3	x4	
0200-1000	ART 7.2	*MTP 17-5-0011.17-KCRW Establish and Maintain Communications	ARV 3			x0		x2	x3	x4	
0757-0802	ART 7.2	*LSI A1.6.2.1.1.4.3 Report Enemy Information	ARV 3			x0		x2	x3	x4	
0200-1000	ART 7.2	*MTP 07-1-1COP.07-C332 Establish the Common Operational Picture	C2V			x0	x1	x2	x3	x4	x5
0200-0205, 0253-0258, 0308-0313, 0341-0346, 0437-0442, 0525-0530, 0633-0638, 0707-0712, 0800-0805, 0849-0854	ART 7.2	*ART 7.2.5 Disseminate Common Operational Picture and Execution Information	C2V			x0	x1	x2	x3	x4	x5
0200-1000	ART 7.2	LSI A2.3.1 Collect Relevant Information ART 7.2.1	C2V								
0200-1000	ART 7.2	MTP 07-1-WT06.07-C332 Conduct Battle Tracking	C2V								
0200-1000	ART 7.2	*MTP 17-5-0011.17-KCRW Establish and Maintain Communications	C2V								
0255-0300, 0313-0318, 0339-0344, 0410-0415, 0523-0528, 0612-0617, 0706-0711, 0750-0755, 0844-0849	ART 7.2	*LSI A1.6.2.1.1.4.3 Report Enemy Information	C2V								
0210-0542	ART 7.2	*MTP 17-5-0011.17-KCRW Establish and Maintain Communications	UAV 1								
0250-0255, 0305-0310, 030-0335	ART 7.2	*LSI A1.6.2.1.1.4.3 Report Enemy Information	UAV 1								
0340-0835	ART 7.2	*MTP 17-5-0011.17-KCRW Establish and Maintain Communications	UAV 2			x0	x1				
0431-0436, 0715-0720	ART 7.2	*LSI A1.6.2.1.1.4.3 Report Enemy Information	UAV 2			x0	x1				
0543-1000	ART 7.2	*MTP 17-5-0011.17-KCRW Establish and Maintain Communications	UAV 3			x0	x1				

TIMELINES / P-Lines / Sheet3 /



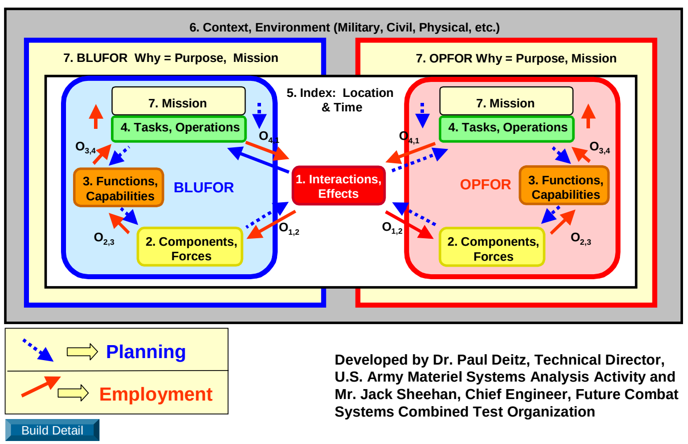
MMF Formal Process Diagram



Outline

Missions and Means Framework Model

11 Fundamental Elements: 7 levels, 4 operators



- Introduction
- Background/MMF Review
- Using MMF to get to the “So What”
- Practical application – How MMF can be applied to ask the right questions and organize the resulting information.
- A few examples of MMF application to T&E
- Conclusion/Summary

MMF T&E Example

TJE Brief

FCS CTO

(PLACEHOLDER)

	A
1	**Level 3 Required Capabilities to Train-JCAS_JCID**
2	**Battlespace Awareness.**
3	
4	Provide for the development, maintenance and dissemination of Common Operating Picture (COP) %
5	Integrate LVC data into the Common Operational Picture (COP)
6	Provide for ability to view and collect data from the Common Operational Picture (COP)#, %
7	Develop and Maintain Battle Space Awareness via Common Operating Picture (COP)
8	Ensure key C2 nodes such as JFACC, JFLCC, CAOC, ASOC, TACC, DASC have adequate communications systems (including secure comms) #
9	Integrate range COP and data collection
10	Provide for target location at all levels of visibility%
11	Provide for target designation at all levels of visibility%
12	Provide for collaborative mission planning%
13	Provide for collaborative mission rehearsal
14	Provide for positive target identification at all levels of visibility
15	Provide training situations for practice of Battle Damage Assessment (BDA) and integration of BDA with other data for overall combat
16	Ensure timely coordination and integration of Battle Damage Assessment (BDA) reports from aircrew and venue generated sources#
17	Provide for JCAS Battle Damage Assessment (BDA)
18	Provide virtual and constuctive training to improve battlefield situational awareness of entities (friend, foe, neutral or other non-combatant) in the tactical battlespace and target location data, including updating vehicles and other entites with correct signatures
19	
20	**Command and Control.**
21	
22	Mandate and facilitate the use of automated systems for C2 by BCT's (I.e.Command and Control Personal Computer (C2PC) or Force Battle Command Battalion/Brigade and Below (FBCB2)#)
23	Mandate exercise planning takes into account peacetime training constraints (location restrictions, airspace, weapons availability,availability of C4I systems, etc) to minimize the impact on training.#
24	Provide or establish Joint Force command and control (C2) structure for events
25	Provide training in forward area Command and Control (C^2) of aircraft
26	Ensure ATO and SPINS concur for C4 capabilities#
27	Mandate and facilitate C2 and equipment requirements are addressed for training and observer monitoring:#
28	Provide complete air picture at command nodes (CAOC)#
29	Provide for Joint Close Air Support (JCAS) Command & Control (C2) needed to synchronize JCAS and ground maneuver
30	Facilitate training in coordinating airspace for UAV support#,%
31	Provide for constructive command nodes to provide all appropriate orders and instructions (comm plan, ATO, SPINS, etc.)#
32	Require exercise communications architecture replicate real world operational architecture#
33	Provide for information exchange via interoperable communications (visual / voice / digital)%
34	Enable Have Quick Interoperability#
35	Mandate Commander development of Annex K for Op Order#
36	Provide ability for OC's to access key communications and coordination nodes#, %
37	Provide for communications between range sites; CAOC-N and NTC air assets, Battlefield Coordination Detachment (BCD) #
38	Mandate, facilitate and Provide for the use of Joint Data Network (JDN) IAW doctrine and TTP#
39	Facilitate training in Airspace Coordination Area activation and deactivation between Division Tactical Operations Center (DTOC), BCT, and Direct Support artillery battalion TOCs#,%
40	Provide for real-time information exchange via interoperable communications (visual / voice / digital)
41	Establish Joint training strategy

Sample list

Level 3 Required Capabilities To Train / JNTC MMF JRMD JCAS FAA Tasks	Battlespace Awareness	Provide for the development, maintenance and dissemination of Common Operating Picture (COP)%	Integrate LVC data into the Common Operational Picture (COP)	Provide for ability to view and collect data from the Common Operational Picture (COP)#, %	Develop and Maintain Battle Space Awareness via Common Operating Picture (COP)	Integrate range COP and data collection	Provide for target location at all levels of visibility%	Provide training situations for practice of Battle Damage Assessment (BDA) and integration of BDA with other data for overall combat assessment	Ensure timely coordination and integration of Battle Damage Assessment (BDA) reports from aircrew and venue generated sources#	Provide for JCAS Battle Damage Assessment (BDA)	Provide virtual and constructive training to improve battlefield situational awareness of entities (friend, foe, neutral or other non-combatant) in the tactical battlespace and target location data, including updating vehicles and other entites with correct signatures	Detect and report targets	Command and Control	Ensure key C2 nodes such as JFACC, JFLCC, CAOC, ASOC, TACC, DASC have adequate
ST 3.1.2 Assign Joint/Multinational Theater Firepower to Targets/Target Systems		x	x	x	x	x		x				x		x
ST 3.2.3 Synchronize Theater Strategic Firepower		x	x	x	x	x								x
OP 2.2.5 Collect Target Information		x	x	x	x	x	x	x	x	x	x	x		x
OP 2.4.2.4 Provide Target Intelligence for the Joint Operations Area (JOA)		x	x	x	x	x	x	x	x	x	x	x		x
OP 3.1.1 Establish Joint Force Targeting Guidance														x
OP 3.1.3 Develop Operational Targets			x				x				x	x		
OP 3.1.5 Publish Air Tasking Order(s) (ATO)							x							x
OP 3.1.8 Coordinate Immediate Targets for Two or More Components		x	x	x	x	x	x				x	x		x
OP 3.2.1 Provide Close Air Support Integration for Surface Forces		x	x	x	x	x	x	x	x	x	x	x		x
OP 3.2.7 Synchronize Operational Firepower		x	x	x	x	x	x		x		x	x		x
OP 5.1.1 Communicate Operational Information		x	x	x	x	x	x					x		x
OP 5.1.11 Provide Positive Identification of Friendly Forces Within the Joint Operations Area		x	x	x	x	x	x				x	x		x
OP 5.3.1 Conduct Operational Mission Analysis		x	x	x	x	x	x	x	x	x	x	x		x
OP 5.4.3 Provide Rules of Engagement		x												
OP 6.1.3.1 Employ Positive Control Measures		x	x	x	x	x					x			x
TA 2.4 Disseminate Tactical Warning Information and Attack Assessment		x	x	x	x	x		x	x	x	x	x		x
TA 3.2.2 Conduct Close Air Support		x	x	x	x	x	x	x	x	x	x	x		x
TA 3.3 Coordinate Battlespace Maneuver and Integrate with Firepower		x	x	x	x	x	x	x	x	x	x	x		x
TA 6.5 Provide for Combat Identification		x	x	x	x	x	x				x	x		x
NTA 2.2.1 Collect Target Information		x	x	x		x	x				x	x		x
NTA 3.1.5 Conduct Tactical Combat Assessment		x	x	x		x	x	x	x	x				
NTA 3.2.2 Attack Enemy Land Targets		x	x	x			x							x
NTA 3.2.4 Suppress Enemy Air Defenses (SEAD)		x	x	x			x							x
NTA 3.2.8 Conduct Fire Support		x	x	x			x			x				x
NTA 5.1.1 Communicate Information		x	x	x		x		x	x			x		x
NTA 5.1.3.1 Maintain and Display Tactical Picture		x	x	x	x	x	x	x	x		x	x		x
NTA 5.1.3.2 Maintain and Display Force Command and Coordination Status		x	x	x	x	x	x	x	x		x	x		x
NTA 5.4.3 Synchronize Tactical Operations and Integrate														

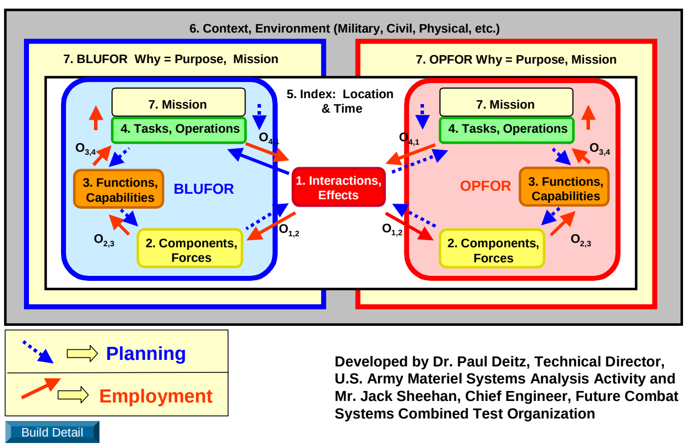
	WRC Facilities / Level 3 Required Capabilities to Train	NTC, Ft Irwin, CA	Nellis AFB, NV	MCAGCC, 29 Palms, CA	Naval Station San Diego, CA	VSMR, NM	NAS Fallon, NV
2	**Battlespace Awareness.**						
3							
4	Provide for the development, maintenance and dissemination of Common Operating Picture (COP) %	4	4	8	4	4	4
5	Integrate LVC data into the Common Operational Picture (COP)	4	4	8	4	4	4
6	Provide for ability to view and collect data from the Common Operational Picture (COP)#, %	4	4	8	1	4	1
7	Develop and Maintain Battle Space Awareness via Common Operating Picture (COP)	4	4	8	1	4	1
8	Ensure key C2 nodes such as JFACC, JFLCC, CAOC, ASOC, TACC, DASC have adequate communications systems (including secure comms) #	4	0	8	1	0	8
9	Integrate range COP and data collection	4	4	8	1	4	1
10	Provide for target location at all levels of visibility%	4	4	[illegible]	4	4	4
11	Provide for target designation at all levels of visibility%	4	4	[illegible]	4	4	4
12	Provide for collaborative mission planning%	4	[illegible]	[illegible]	4	4	4
13	Provide for collaborative mission rehearsal	4	[illegible]	[illegible]	4	4	4
14	Provide for positive target identification at all levels of visibility	4	[illegible]	1	1	1	1
15	Provide training situations for practice of Battle Damage Assessment (BDA) and integration of BDA with other data for overall combat assessment	[illegible]	[illegible]	1	4	1	4
16	Ensure timely coordination and integration of Battle Damage Assessment (BDA) reports from aircrew and venue generated [illegible] sources#	[illegible]	4	4	4	4	4
17	Provide for JCAS Battle Damage Assessment (BDA)	[illegible]	1	4	4	1	4
18	Provide virtual and constuctive training to improve battlefield situational awareness of entities (friend, fo[illegible] combatant) in the tactical battlespace and target location data, including updating vehicles and other e[illegible] signatures	4	8	8	8	8	8
19							
20	**Command and Control.**						
21							
22	Mandate and facilitate the use of automated systems for C2 by BCT's (I.e.Command and Control Personal Computer (C2PC) or Force Battle Command Battalion/Brigade and Below (FBCB2)#)	4	0	8	8	4	0
23	Mandate exercise planning takes into account peacetime training constraints (location restrictions, airspace, weapons availability,availability of C4I systems, etc) to minimize the impact on training.#	4	4	4	4	4	4
24	Provide or establish Joint Force command and control (C2) structure for events	4	4	4	4	4	4
25	Provide training in forward area Command and Control (C^2) of aircraft	4	4	1	1	4	1
26	Ensure ATO and SPINS concur for C4 capabilities#	4	4	4	4	4	4
27	Mandate and facilitate C2 and equipment requirements are addressed for training and observer monitoring:#	4	1	1	1	1	1
28	Provide complete air picture at command nodes (CAOC)#	4	4	4	4	4	4
29	Provide for Joint Close Air Support (JCAS) Command & Control (C2) needed to synchronize JCAS and ground maneuver	4	1	1	1	1	1
30	Facilitate training in coordinating airspace for UAV support#,%	4	1	8	1	1	1
31	Provide for constructive command nodes to provide all appropriate orders and instructions (comm plan, ATO, SPINS, etc.)#	4	4	4	4	4	4
32	Require exercise communications architecture replicate real world operational architecture#	4	7	4	7	1	7
33	Provide for information exchange via interoperable communications (visual / voice / digital)%	4	7	4	4	1	4
34	Enable Have Quick Interoperability#	8	1	8	8	8	1
35	Mandate Commander development of Annex K for Op Order#	4	1	1	1	1	1
36	Provide ability for OC's to access key communications and coordination nodes#, %	4	8	8	1	8	8
37	Provide for communications between range sites; CAOC-N and NTC air assets, Battlefield Coordination Detachment (BCD) #	4	7	8	1	1	4
38	Mandate, facilitate and Provide for the use of Joint Data Network (JDN) IAW doctrine and TTP#	8	1	8	8	1	8
39	Facilitate training in Airspace Coordination Area activation and deactivation between Division Tactical Operations Center (DTOC), BCT, and Direct Support artillery battalion TOCs#,%	4	8	8	8	4	8

NOTIONAL VALUES

Outline

Missions and Means Framework Model

11 Fundamental Elements: 7 levels, 4 operators



Developed by Dr. Paul Deitz, Technical Director, U.S. Army Materiel Systems Analysis Activity and Mr. Jack Sheehan, Chief Engineer, Future Combat Systems Combined Test Organization

- Introduction
- Background/MMF Review
- Using MMF to get to the "So What"
- Practical application – How MMF can be applied to ask the right questions and organize the resulting information.
- A few examples of MMF application to T&E
- Conclusion/Summary

Conclusion/Summary

- Top – Down driven Mission to Task Decomposition Process necessary to identify tasks required to accomplish the Mission – Important to determining ESS.
- Military Professionals use doctrinal processes to analyze Missions, plan Operations and monitor and assess progress towards accomplishing Mission during execution.
- The MMF provides a disciplined and structured framework that translates these doctrinal processes into a detailed data set that enables a common framework of understanding between stakeholder communities

Missions and Means Framework

11 Fundamental Elements: **Seven Levels, Four Operators**

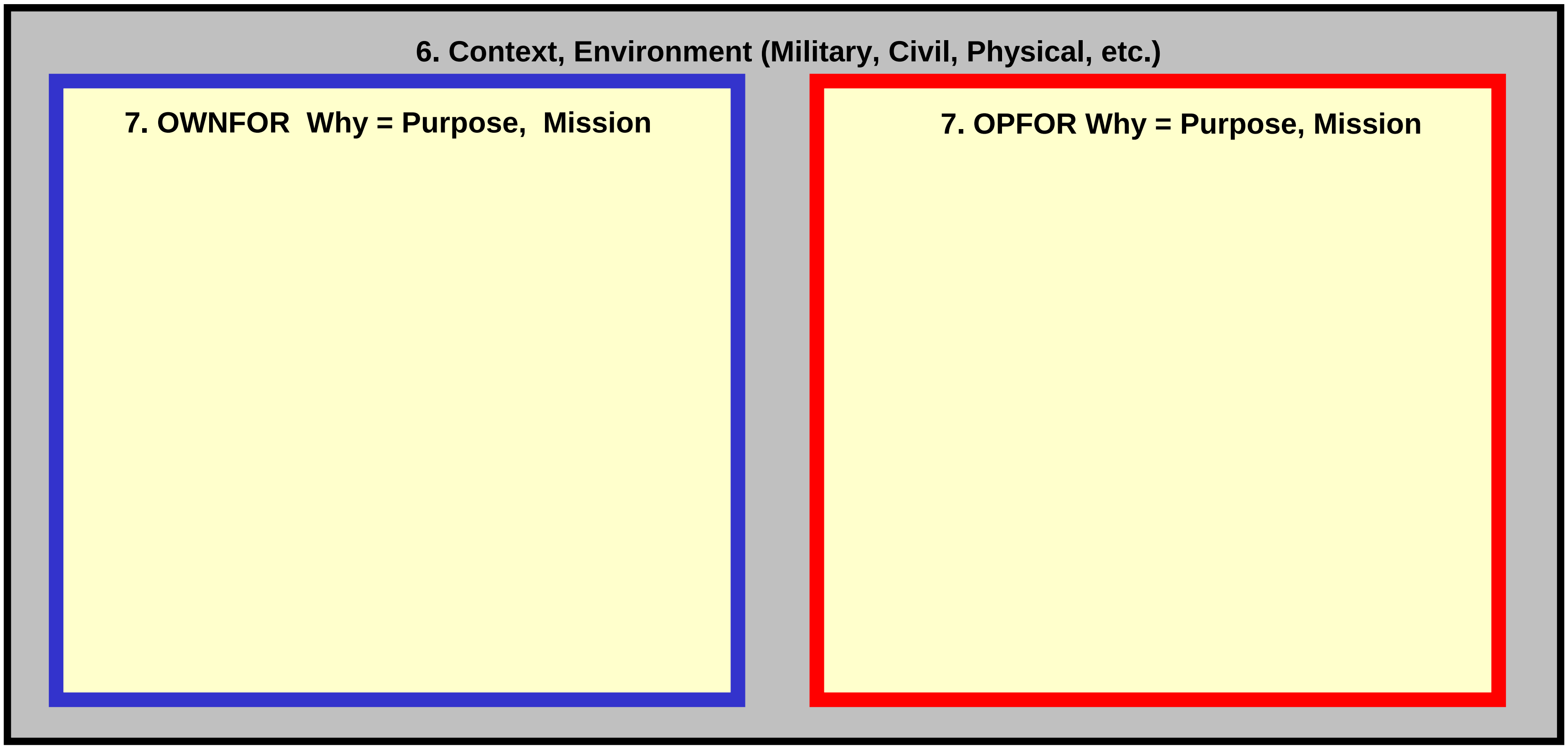
7. OWNFOR Why = Purpose, Mission

7. OPFOR Why = Purpose, Mission

7. Why, Wherefore, to What End

Missions and Means Framework

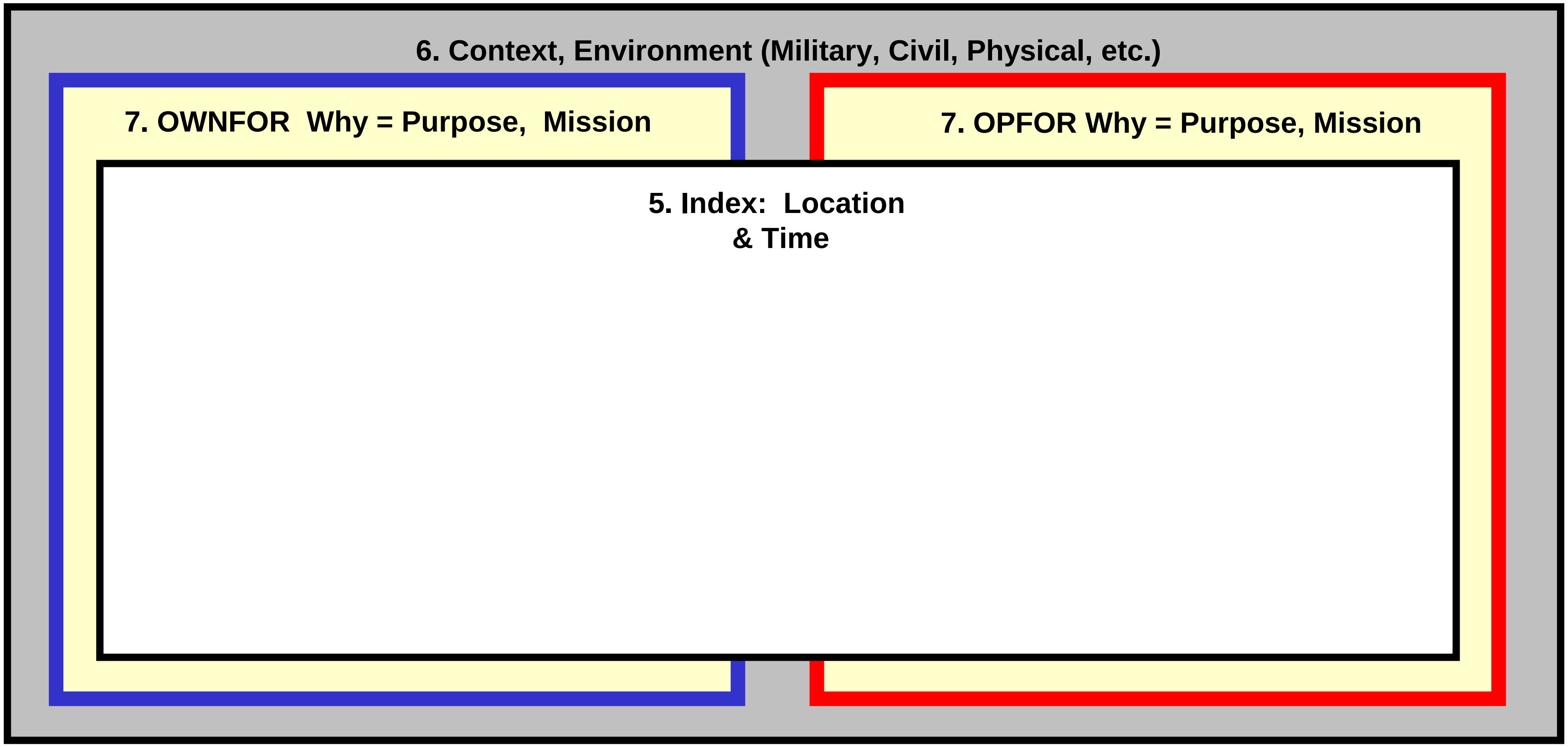
11 Fundamental Elements: **Seven Levels, Four Operators**



6. Under What Circumstances

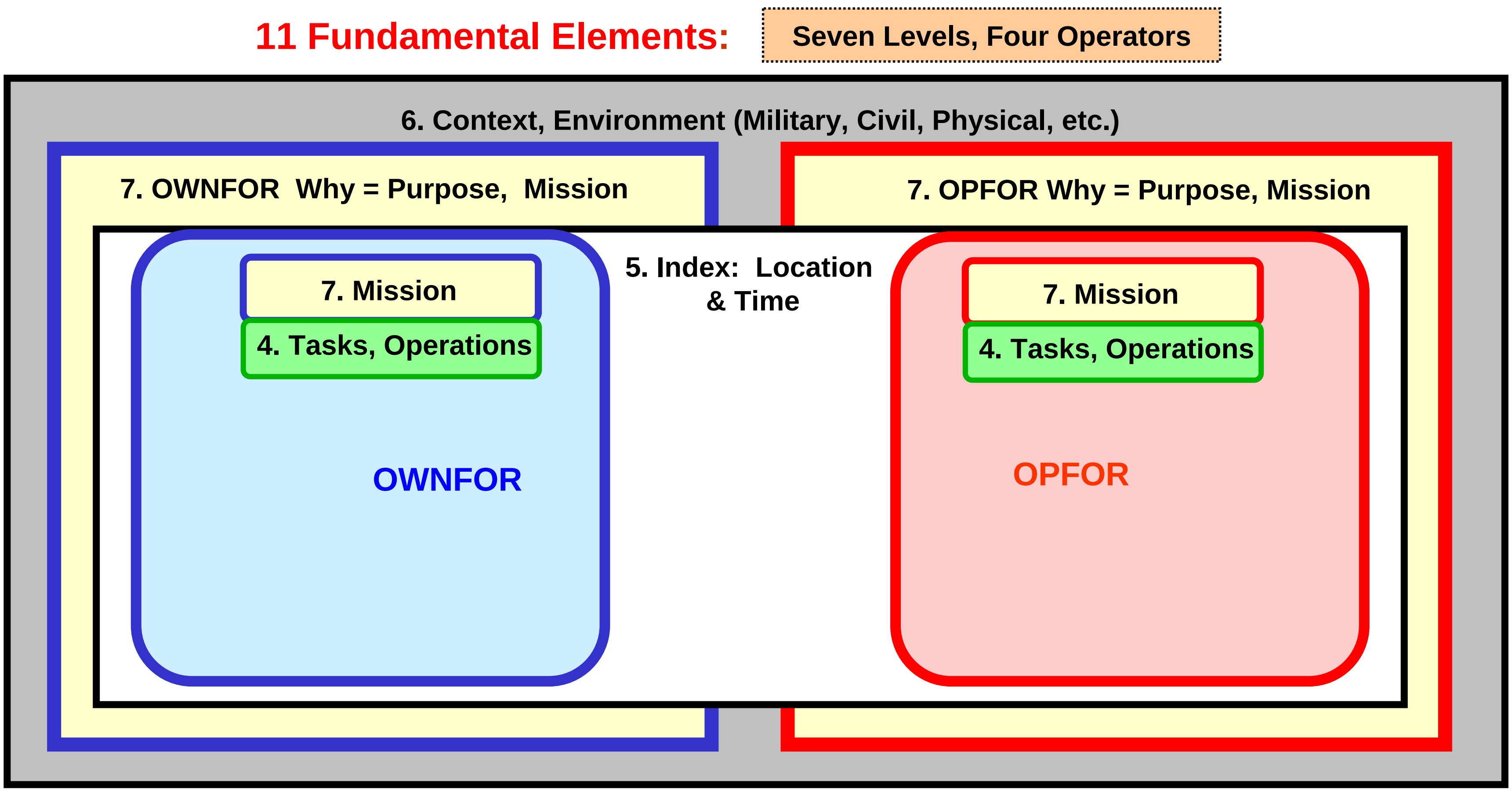
Missions and Means Framework

11 Fundamental Elements: Seven Levels, Four Operators



5. When and Where

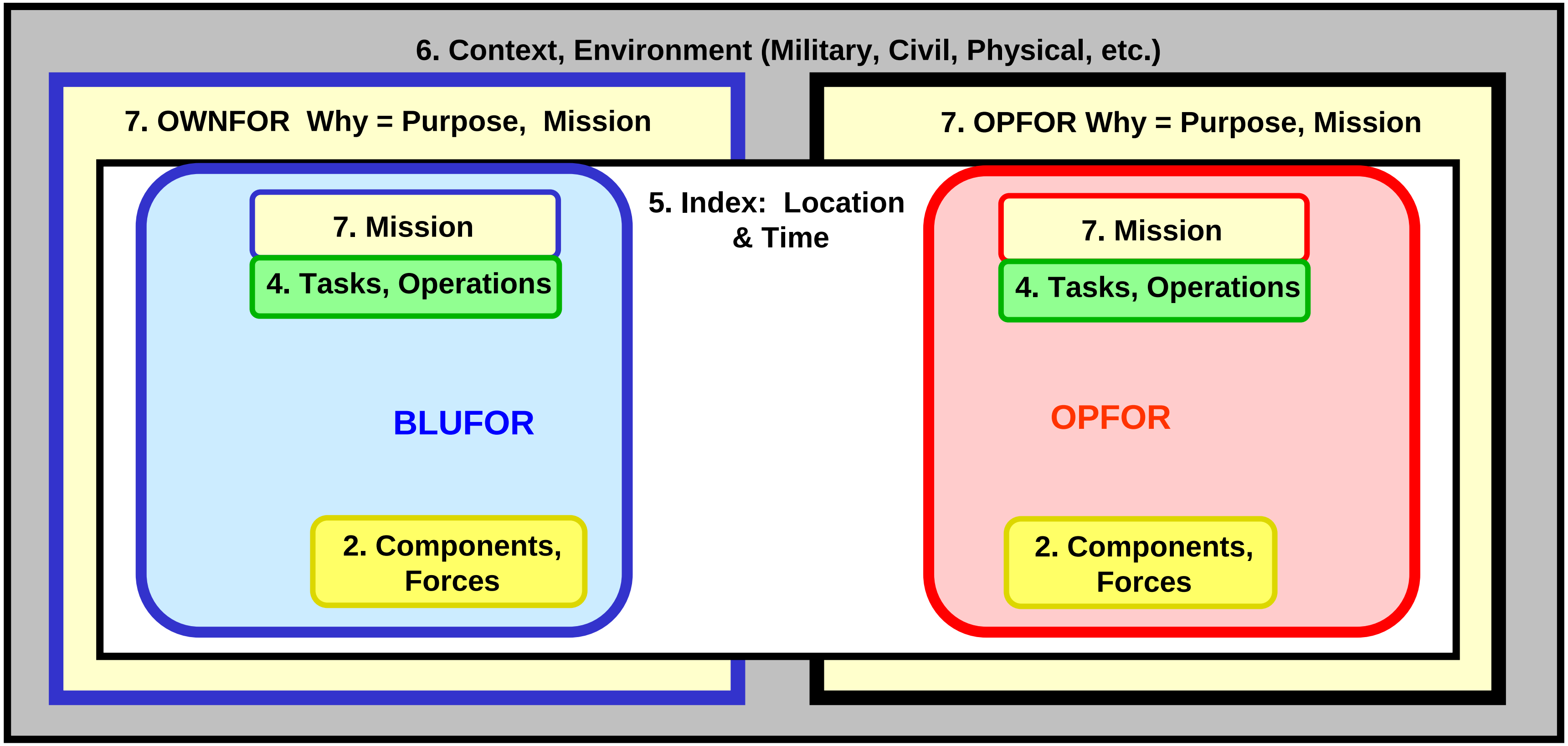
Missions and Means Framework



4. Activity-centric, named with a Verb, "Do What" -- the Playbook

Missions and Means Framework

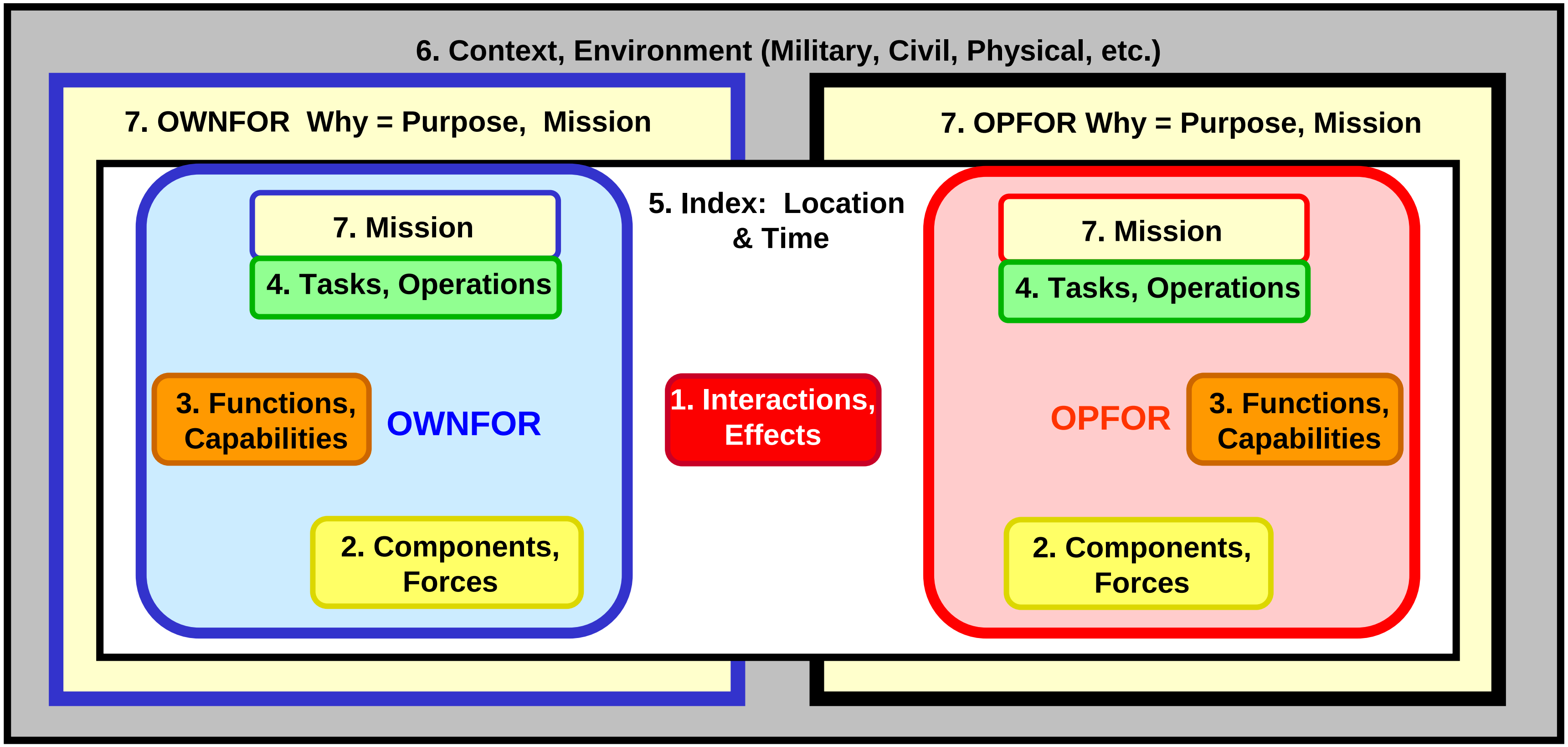
11 Fundamental Elements: Seven Levels, Four Operators



2. Entity-centric, named with a Noun "By Whom" -- the Players

Missions and Means Framework

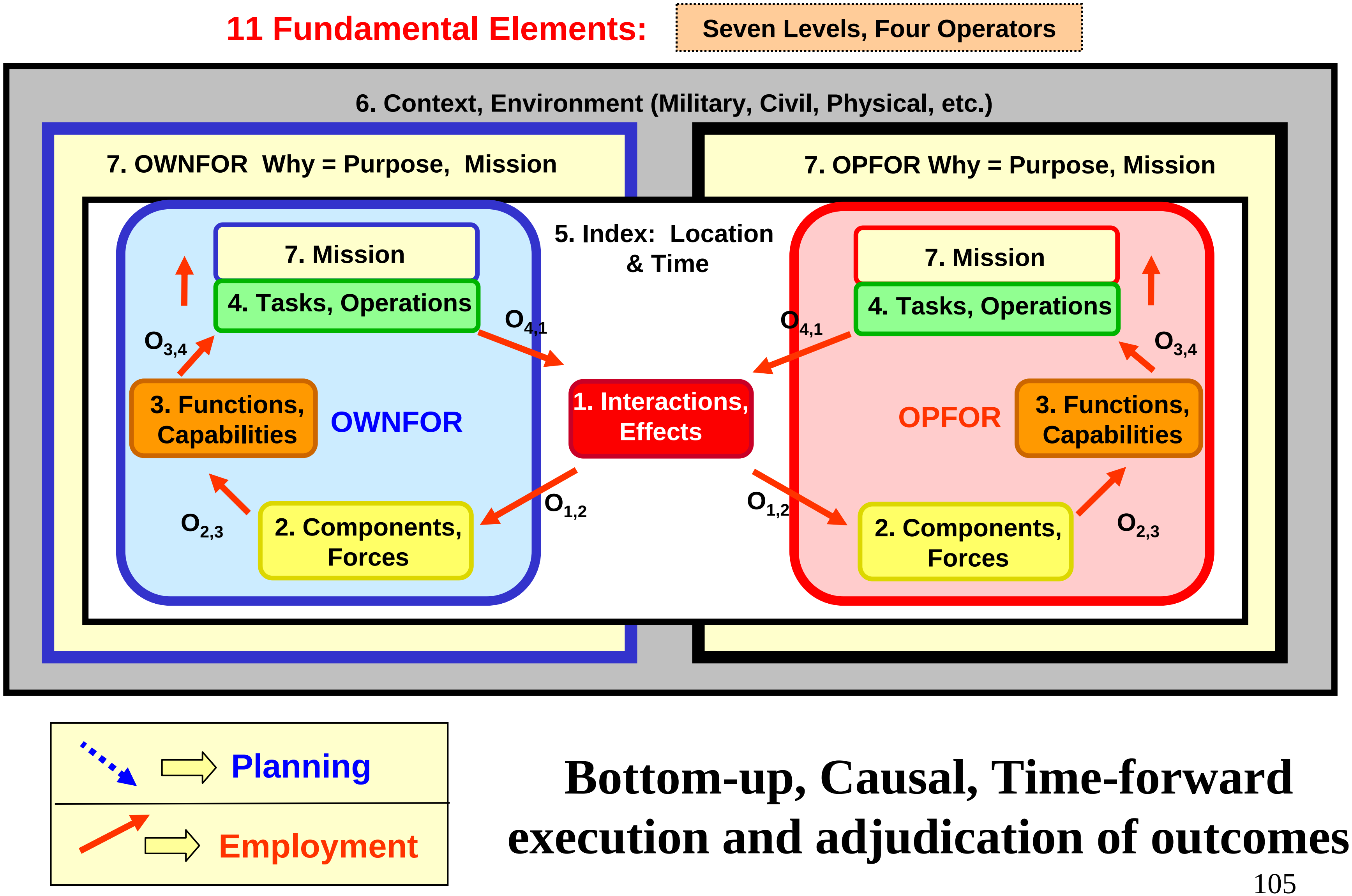
11 Fundamental Elements: Seven Levels, Four Operators



1. The (shared) Slings-and-Arrows of Outrageous Fortune -- Science

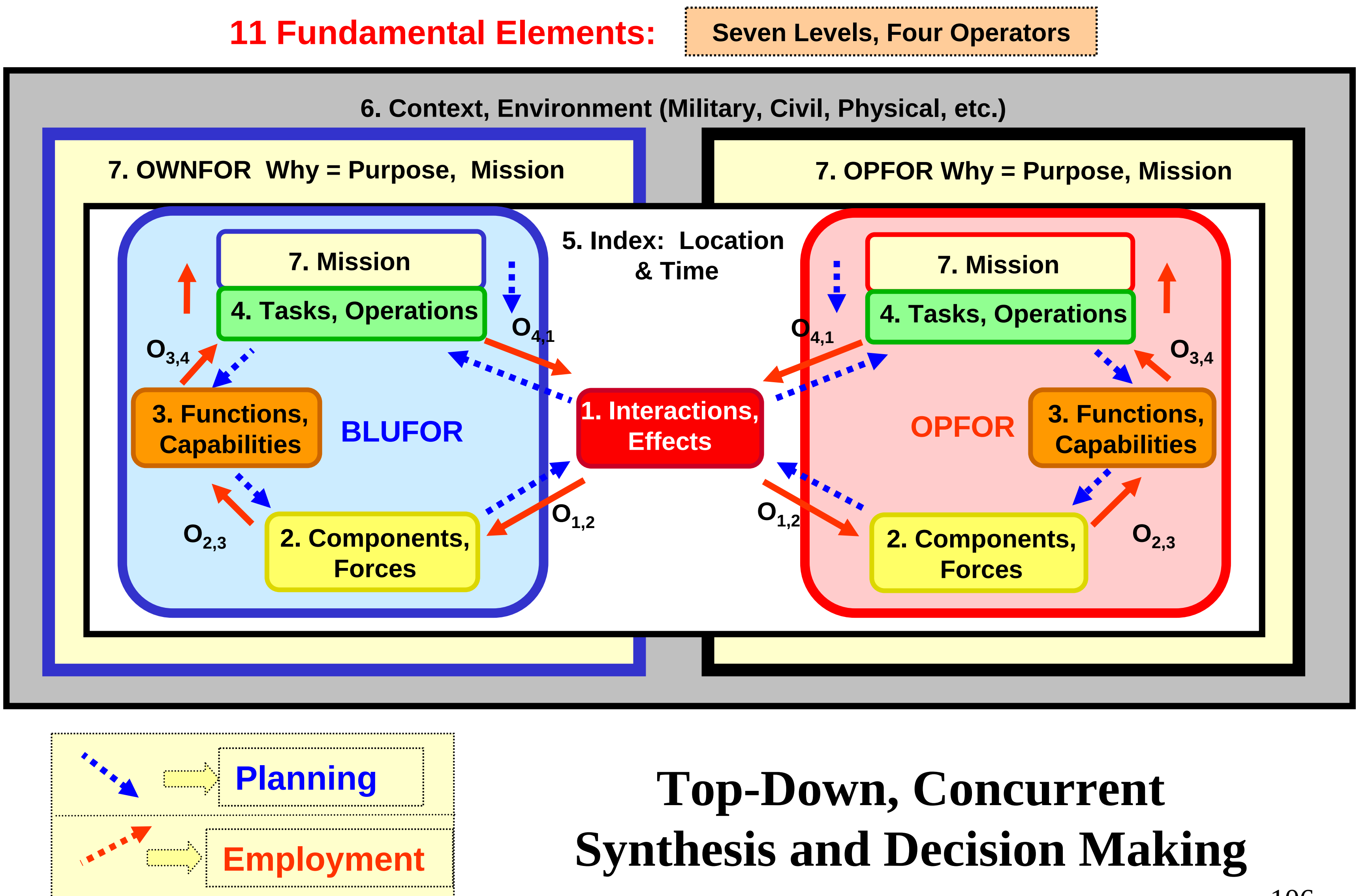
3. Condition-dependent "How Well" -- Engineering

Missions and Means Framework



Bottom-up, Causal, Time-forward execution and adjudication of outcomes

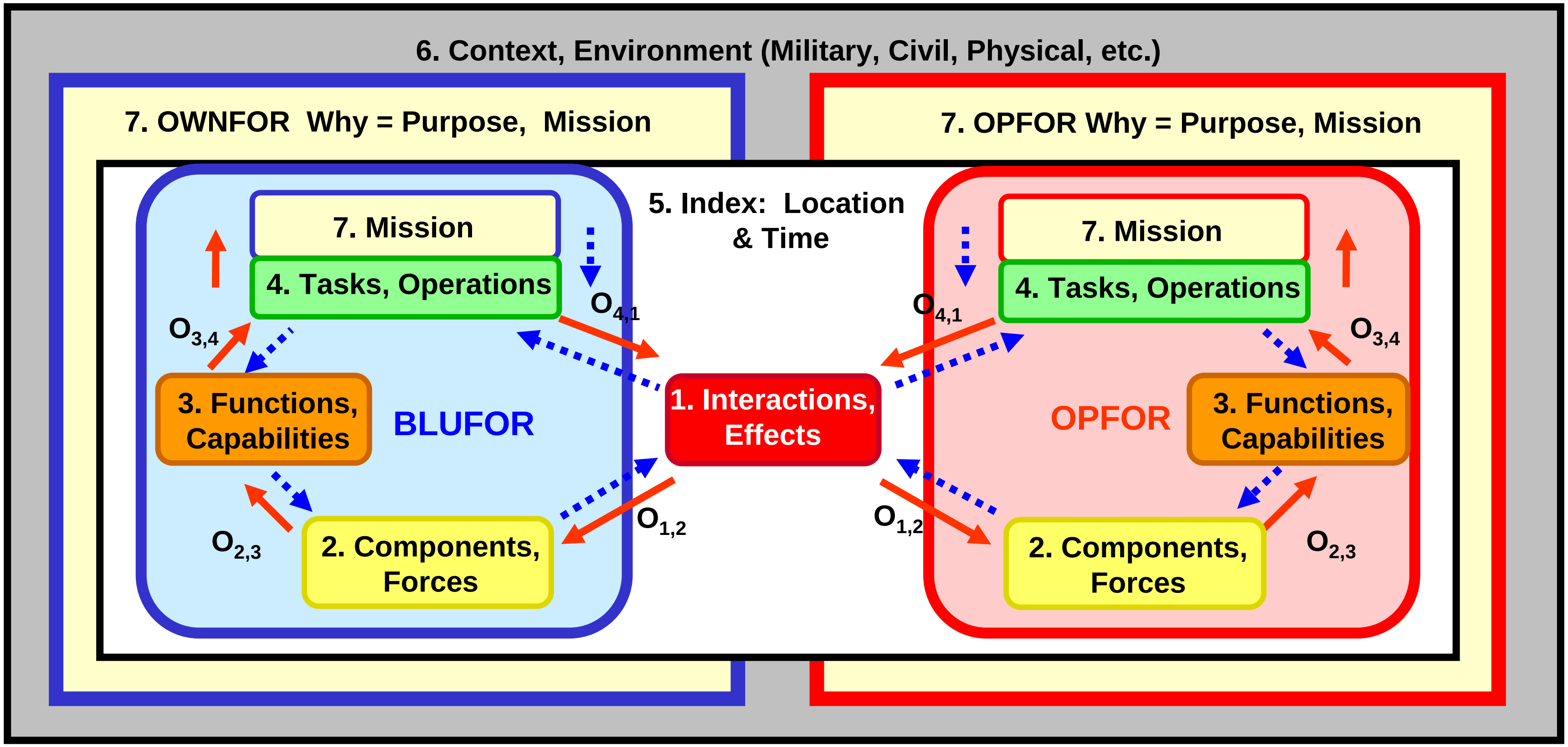
Missions and Means Framework

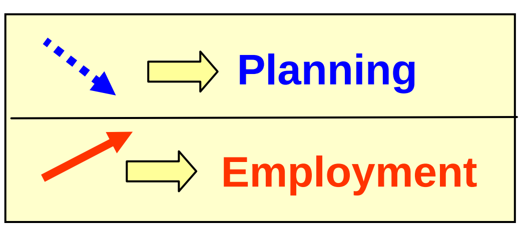


Top-Down, Concurrent Synthesis and Decision Making

Missions and Means Framework

11 Fundamental Elements: Seven Levels, Four Operators





Architecture defines how Parts are assembled into Packages

Return

"No More Second Opinions: Organizing DoD M&S Within the Acquisition Cycle"

by

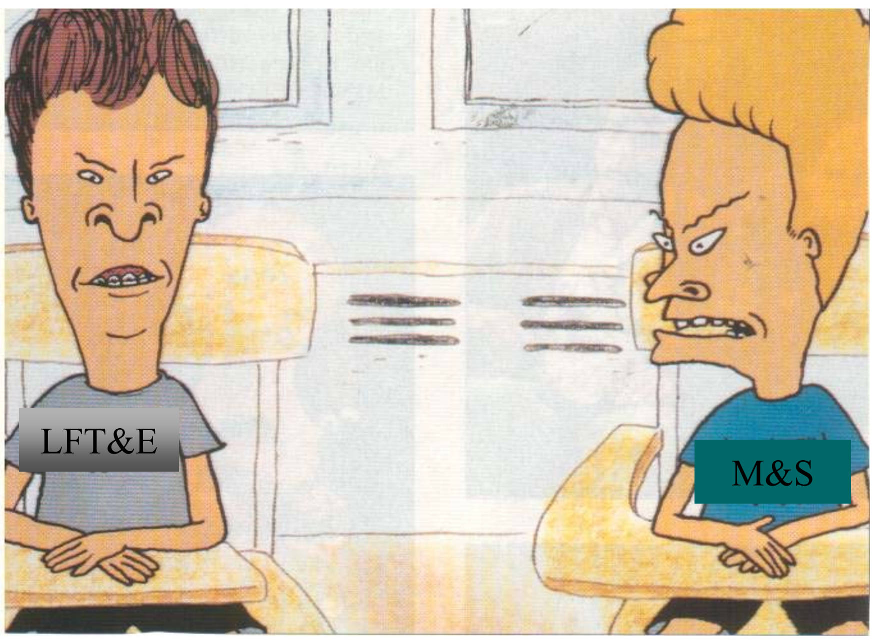
James F. O'Bryon

The O'Bryon Group

443-528-2711

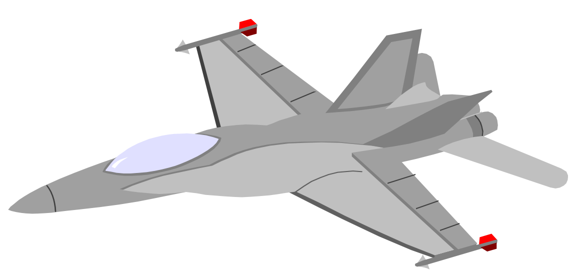
NDIA T&E Conference,
Jacksonville, FL
March 9, 2006

M&S AND T&E ARE PARTNERS, NOT COMPETITORS



MODELING AND SIMULATION
IN
TEST & EVALUATION

Modeling and simulation are an integral part of T&E and not to be looked at as a substitute, nor a means to save money. M&S and testing are mutually supportive and none is complete without the other.



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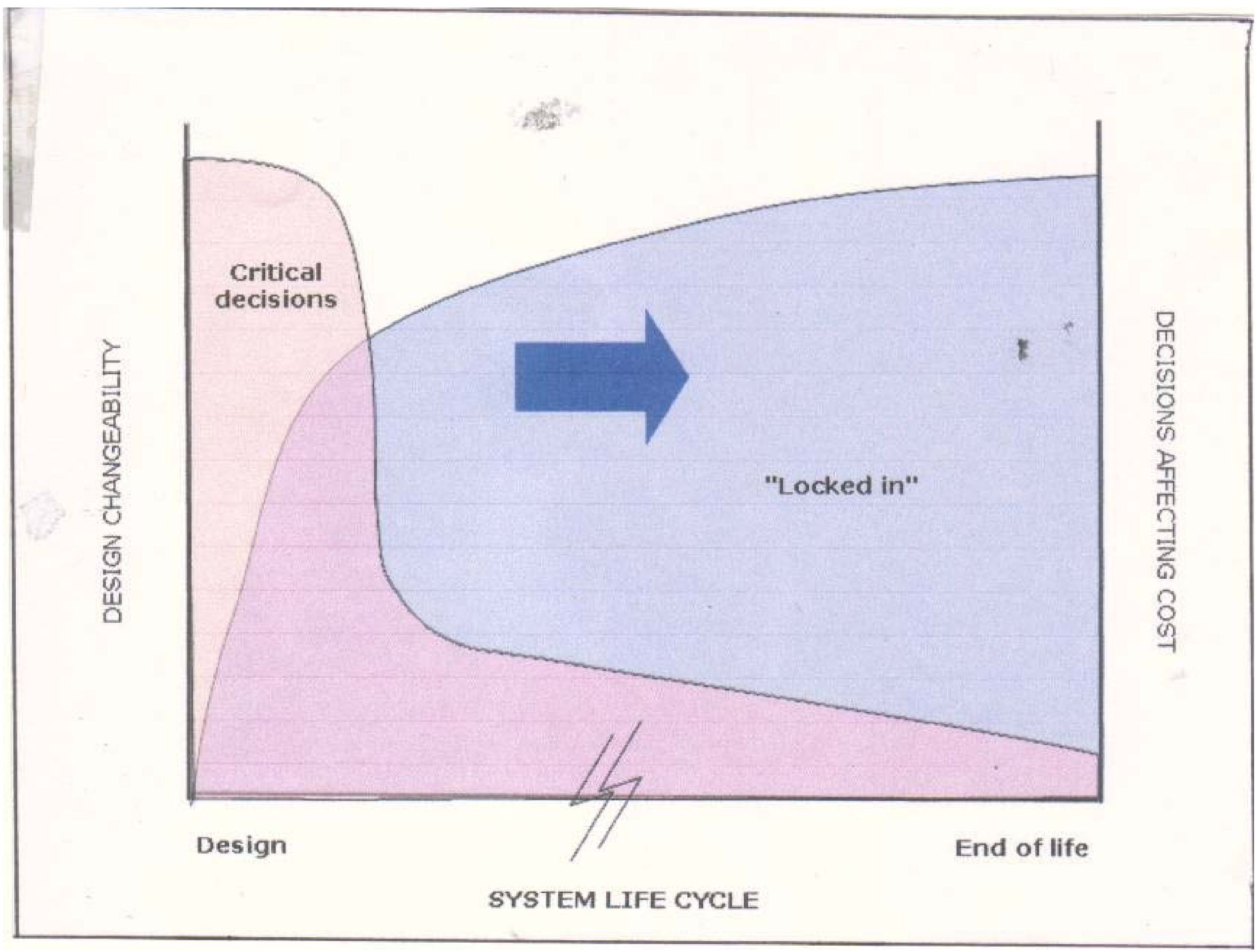
M & S PLAY A VITAL ROLE EARLY ON IN SYSTEM DESIGN AND VERIFICATION

Source: R. Garrett, "Opportunities in Modeling and simulation to Enable Dramatic Improvements in Ordnance Design, "presented to the Committee on Bridging Design and Manufacturing. National Research Council, Washington, DC., April 29, 2003.



A Proposal That Might Work:

Program Manager Magazine

MODELING AND SIMULATION

Meet "MASTER"—Modeling & Simulation Test & Evaluation Reform

Energizing the M&S Support Structure

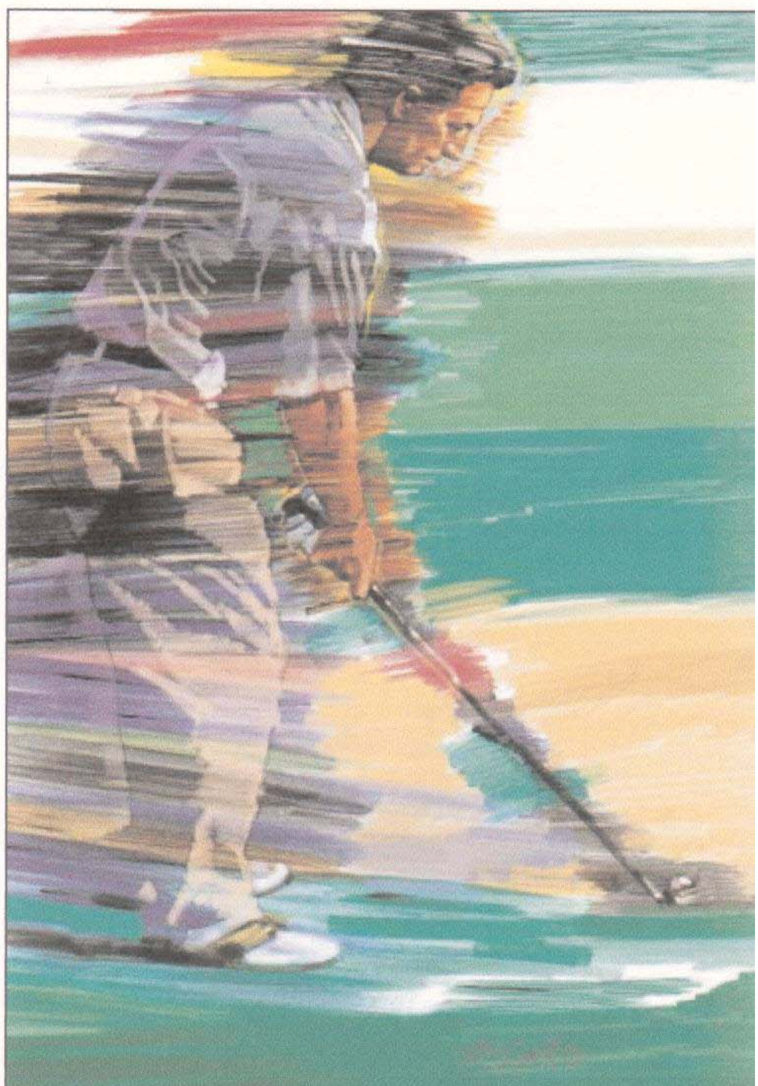
JAMES F. O'BRYON

In the following few pages, I discuss my personal thoughts on an issue of paramount importance not only to the Department of Defense, but also to the nation's defense. My hope is that this article will provoke serious thought and meaningful action to resolve the issues raised.

First, A Look Back

Since arriving in the Pentagon just over 12 years ago, and for more than a decade before that serving as a weapons analyst in the Department of Defense (DoD) infrastructure away from the Washington area, I have been witness to numerous and surprisingly similar technical and management discussions about the need to get the modeling and simulation capabilities of the DoD organized, incentivized, under control, and more efficient to better serve the weapons development and acquisition process.

These discussions included such issues as a common and meaningful model architecture, model inter-connectivity, language consistency, validation, model proliferation, and configuration control. They've also covered the problems of duplication, modeling "stovepipes," the lack of meaningful and up-to-date documentation supporting M&S, and of course, the lack of model realism.



O'Bryon serves as the Deputy Director, Operational Test and Evaluation, Live Fire Testing, in the Office of the Secretary of Defense, The Pentagon, Washington, D.C. His undergraduate degree is in Mathematics, and he also holds two graduate degrees: one in Operations Research from The George Washington University, and another through the Electrical Engineering Department of the Massachusetts Institute of Technology.

TRUTH # 1

TRUTH # 2

TRUTH # 3

TRUTH # 4

"PMs Have Short Time Horizons And, Hence, On Their Investment Decisions"

TRUTH # 5


"Realistic
M&S Is Not
Necessarily
Viewed As A
Benefit By
The PM"

TRUTH # 6

What’s Needed?

“MASTER”

MODELING **A**ND
SIMULATION **T**EST AND
EVALUATION **R**EFORM

What is 'MASTER'?

- **MASTER is a <u>management approach</u> to modeling and simulation in support to the defense department's policy of simulation-based acquisition**
- **It will provide**
  - **<u>critical-mass funding</u>**
  - **add <u>discipline</u> to the development of modeling and simulation**
  - **assure that funds expended on modeling and simulation are spent to <u>further *the state of the art,*</u> including VV&A**
  - **add <u>connectivity</u> across various model vectors being developed**
  - **<u>free up the Program Manager's time & concerns</u> about modeling and simulation support**
  - **assure the most <u>realistic models & simulations</u> are exercised in designing testing, evaluating, training, fielding and fighting our systems.**

Consortium Discussion

Program Managers would initially describe their system(s), acquisition strategy, and M&S requirements to a consortium which would then parse out these needs into vectors of M&S technical responsibility.

Consortium Members, who are charged with having knowledge of *state of the art*, as well as where it exists within and outside of their respective organizations, would make the decisions as to which M&S tools best suit the PM's needs and where the funds would be expended to meet the specific requirements of each Program Manager's system(s). They would upgrade extant models where available and originate M&S only when absolutely necessary. In many instances, these investments would be allocated to organizations external to the Consortium Membership itself.

Must Have Up-Front Investment in M&S!!

"I expect programs to make the **up-front** investment in modeling and simulation application technology, and will be looking for evidence of that investment in program planning and execution."

Honorable Jacques S. Gansler, Under Secretary of Defense (Acquisition and Technology) 1998

If there's no new money, where will the money come from to fund this "MASTER" initiative?

Where Would Money to Fund the Consortium Come From?

A modest tax ("greens fee") would be assessed upon every Program Manager's total budget. These funds would be placed in the Consortium's account to provide the needed M&S support to the Program Manager.

The proposed "tax" would be a percentage of the Program Manager's budget (perhaps 2-3%). This is significantly less than what is currently spent by PM's on a plethora of isolated M&S activities.

The tax would <u>not</u> be at the discretion of the Program. It would be a policy decision and implemented early on at the OSD Comptroller level.

Funds would be removed early to:

- **enable sufficient time to develop the needed M&S, and,**
- **avoid the tendency to cut the funding of modeling and testing programs, when problems arise and budgets get tight**

Potential Modeling Vectors Needed for the Testing and Training Communities

SOME EXAMPLES:

TERRAIN
WEATHER
CADCAM SYSTEM DESCR
AERODYNAMIC FLOW/FLIGHT
STABILITY
6 DOF FLY-OUT
TARGET SIGNATURES
SENSOR/FUZING
SMOKE/OBSCURATION
C3I
EW
ACOUSTIC
BALLISTIC
1-1 ENGAGEMENT
MxN ENGAGEMENT
VULNERABILITY
LOGISTICS
MANY OTHERS

What are Some of the Benefits of Forming a Consortium to Oversee M&S Investment Within the DoD?

1. It would assure that Program Managers have the best and most realistic model support for their programs.
2. It would establish the necessary consortium protocols for model architecture, languages and protocols, insuring that no funds would be invested in model development or upgrades unless they meet these protocols, thereby facilitating interoperability.
3. It would assure that model investments would be directed toward extending the capability of extant models and simulations rather than spending significant funds reinventing and re-buying codes which exist or exist in part.

Consortium Benefits? (Continued)

4. **The structure would provide an adequate source of funding to extend *the state of the art* in the M&S base, instead of being at the whim of the Program Manager, typically trying to maximize the short-term return.**

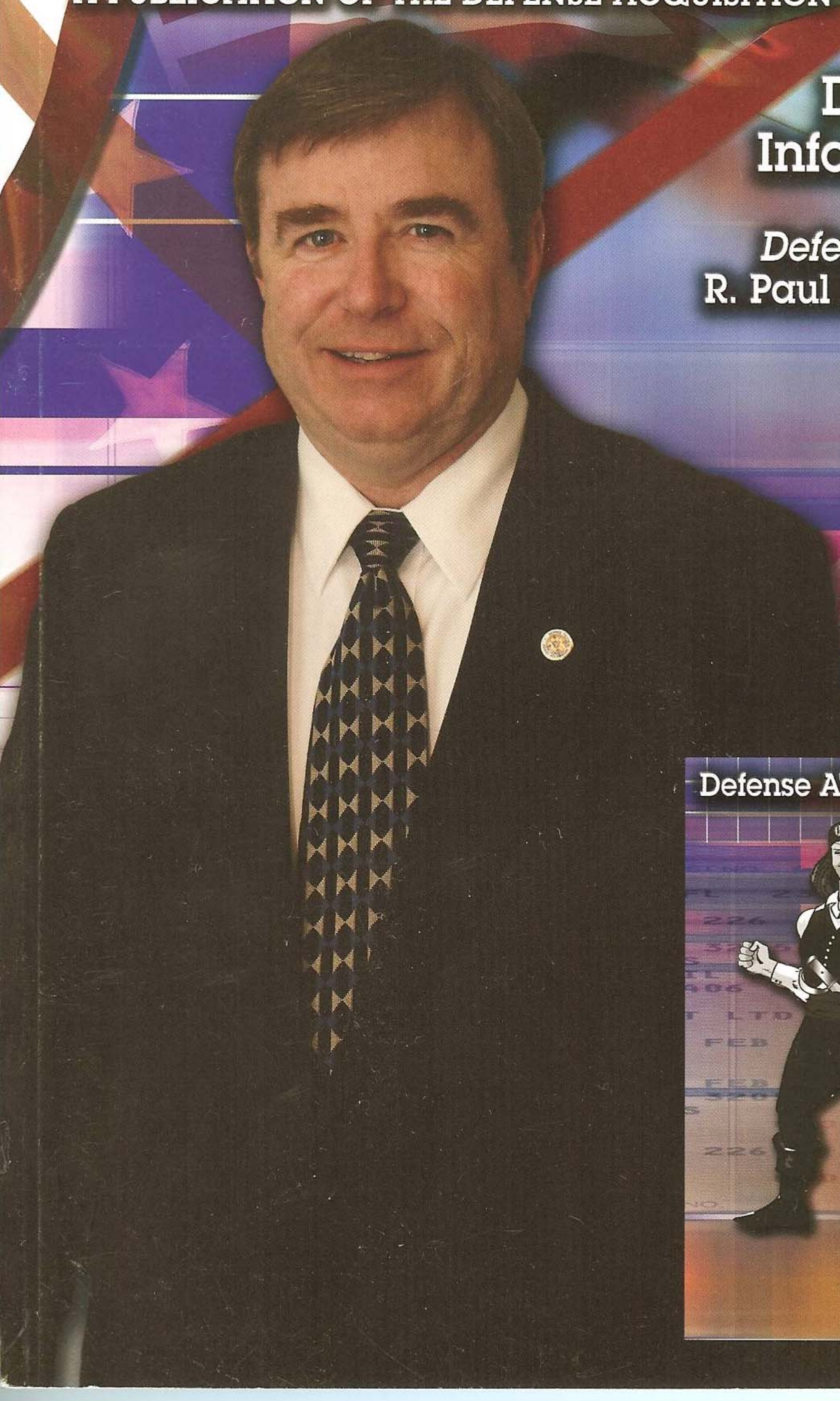
5. **It would focus national expertise in each technical discipline to assure that decisions on which model investments were indeed needed in each of these disciplines.**

6. **It would free up the Program Manager's time and attention to other management responsibilities and allow the Consortium to provide the needed M&S support for each respective program.**

Defense AT&L

March-April 2006

A PUBLICATION OF THE DEFENSE ACQUISITION UNIVERSITY



DoD's Technical Information Broker

Defense AT&L Interviews R. Paul Ryan, Administrator Defense Technical Information Center

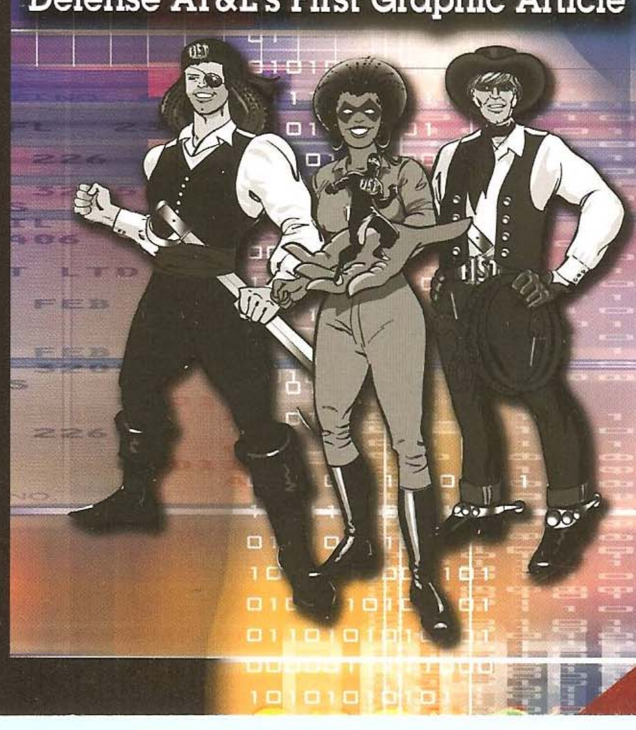
ALSO

America's Imprudent and Unsustainable Fiscal Path

David M. Walker, U.S. Comptroller General

And Introducing

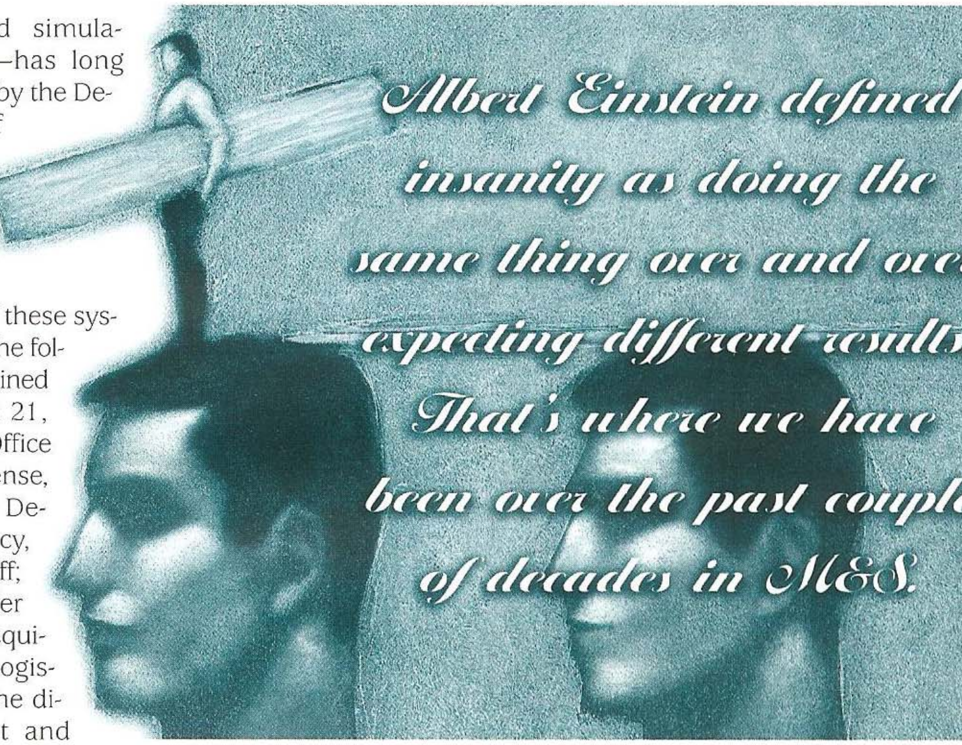
Defense AT&L's First Graphic Article



DoD's Modeling and Simulation Reform in Support of Acquisitior

Stop Kicking the M&S Can Down the Road

James F. O'Bryon



Modeling and simulation—M&S—has long been touted by the Department of Defense as being among its primary methods for reducing time to market for defense systems and reducing the cost of these systems at the same time. The following statement is contained in a letter dated March 21, 2000, addressed to the Office of the Secretary of Defense, Service secretaries, the Defense Intelligence Agency, and the Joint Chiefs of Staff; it is cosigned by the under secretary of defense (acquisition, technology and logistics) (USD(AT&L)) and the director, operational test and evaluation, (DOT&E): "We have stressed that we must make better use of modeling and simulation (M&S) to improve the acquisition process, reduce costs, enhance T&E [test and evaluation], and shorten development times for our new systems. We are convinced that efficient use of M&S throughout the system life cycle will net great dividends in efficiencies."

Few people would argue that M&S is not an important element in the acquisition process. The question is this: Has there been progress within DoD to efficiently organize, fund, develop, promulgate, and maintain configuration control of the DoD's massive and diverse M&S activities to yield the efficiencies so clearly stated in the letter quoted above? Estimates for how much is spent annually on M&S in the DoD range from $5 billion to $30 billion, depending on how one defines M&S. Some of this is spent on M&S in support of training. The majority of the funds, however, are spent in support of the r development, test, and evaluation of new def quisition programs.

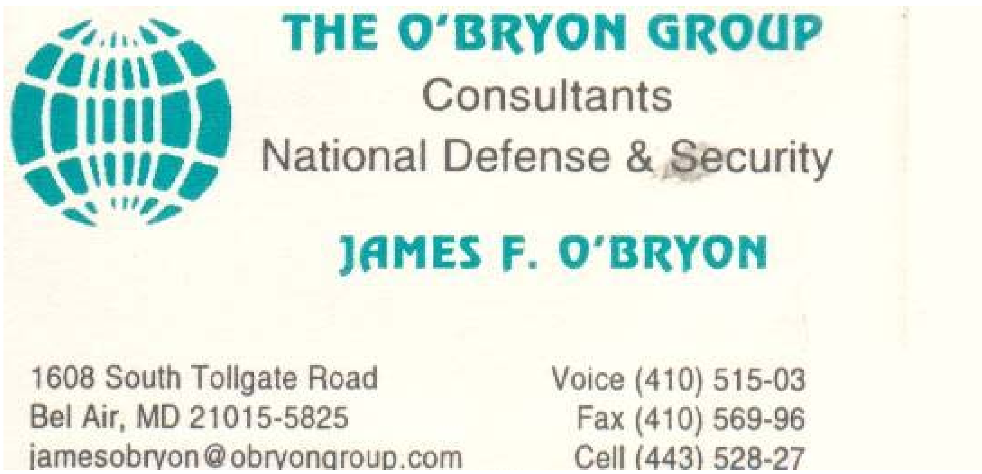
In an article in the July 2005 issue of *National Magazine*, David W. Duma, the Pentagon's acti tor, operational test and evaluation, wrote that fense Department needs to better manage its si programs. I think we've kind of lost our way partment with modeling and simulation. Multip cies are buying duplicate technologies, rather th dinating efforts. We are using more model simulation. But it's not focused, it's scattered. Ev is building their own."

Not a New Problem

I couldn't agree more. So why *does* the DoD co lose its way using more M&S but in a "scattere

O'Bryon *served as deputy director, operational test and evaluation in the Office of the Secretary of Defense until November 2001. He current as a consultant to ORSA Corporation, Aberdeen, Md.*

IF YOU HAVE SOME IDEAS YOU'D LIKE TO SHARE OR WOULD LIKE TO CHALLENGE SOME O THESE IDEAS, I WOULD WELCOME YOUR IDEAS.



Call me at 410-515-0345 or email me at jamesobryon@obryon

Modeling & Simulation

How Can M&S Team Better With DT&E?

Steven E. Cameron

Senior Manager, Modeling & Simulation Infrastructure
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March 7th, 2006

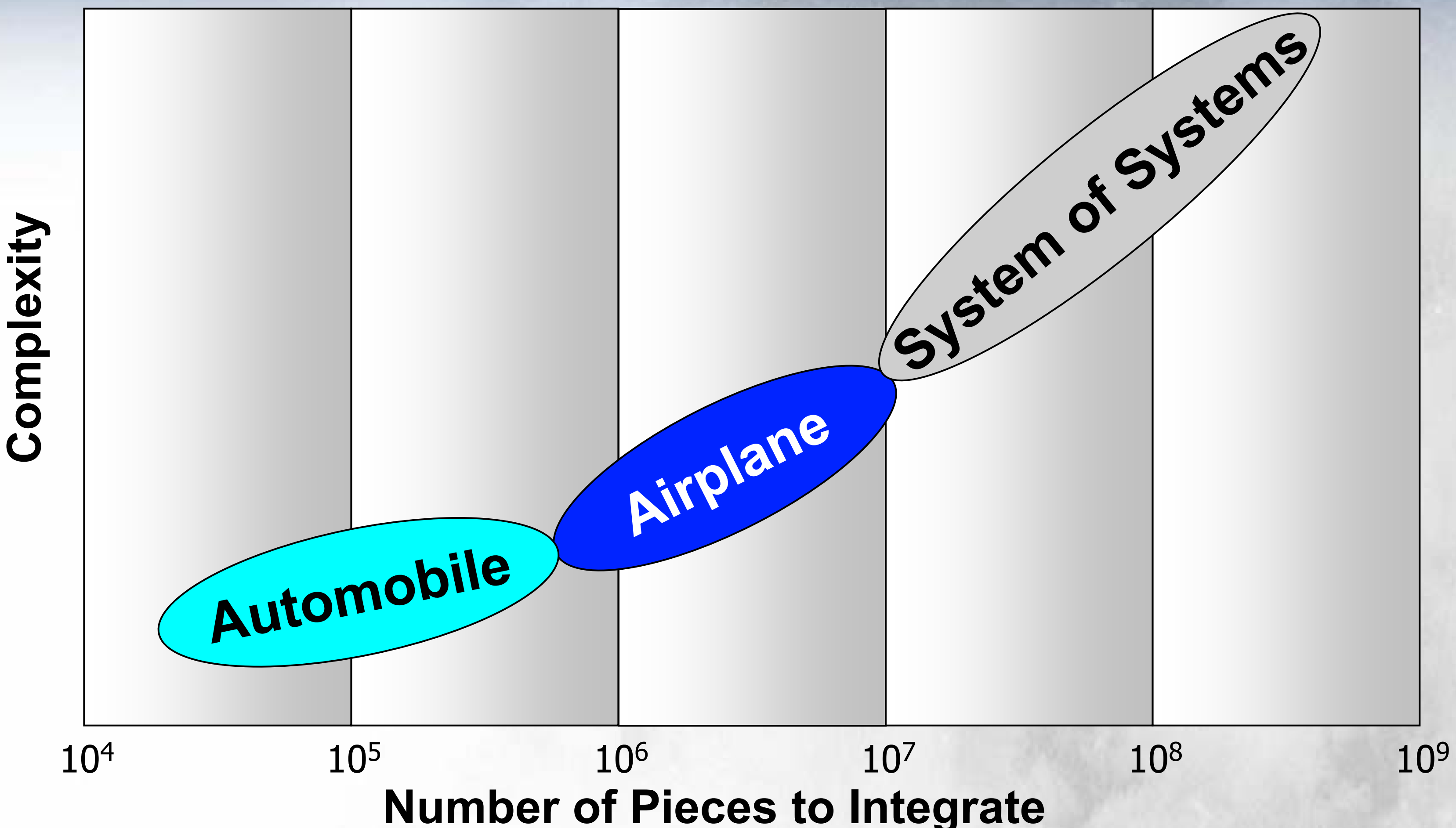
NDIA T&E Forum, Jacksonville, FL

Thoughts

- Industry-government teaming—early and often
- Refinement of Live, Virtual, and Constructive M&S capability
- Industry access to government systems
- Organizational support of M&S in DT&E
- Lifecycle perspective
- Open Standards

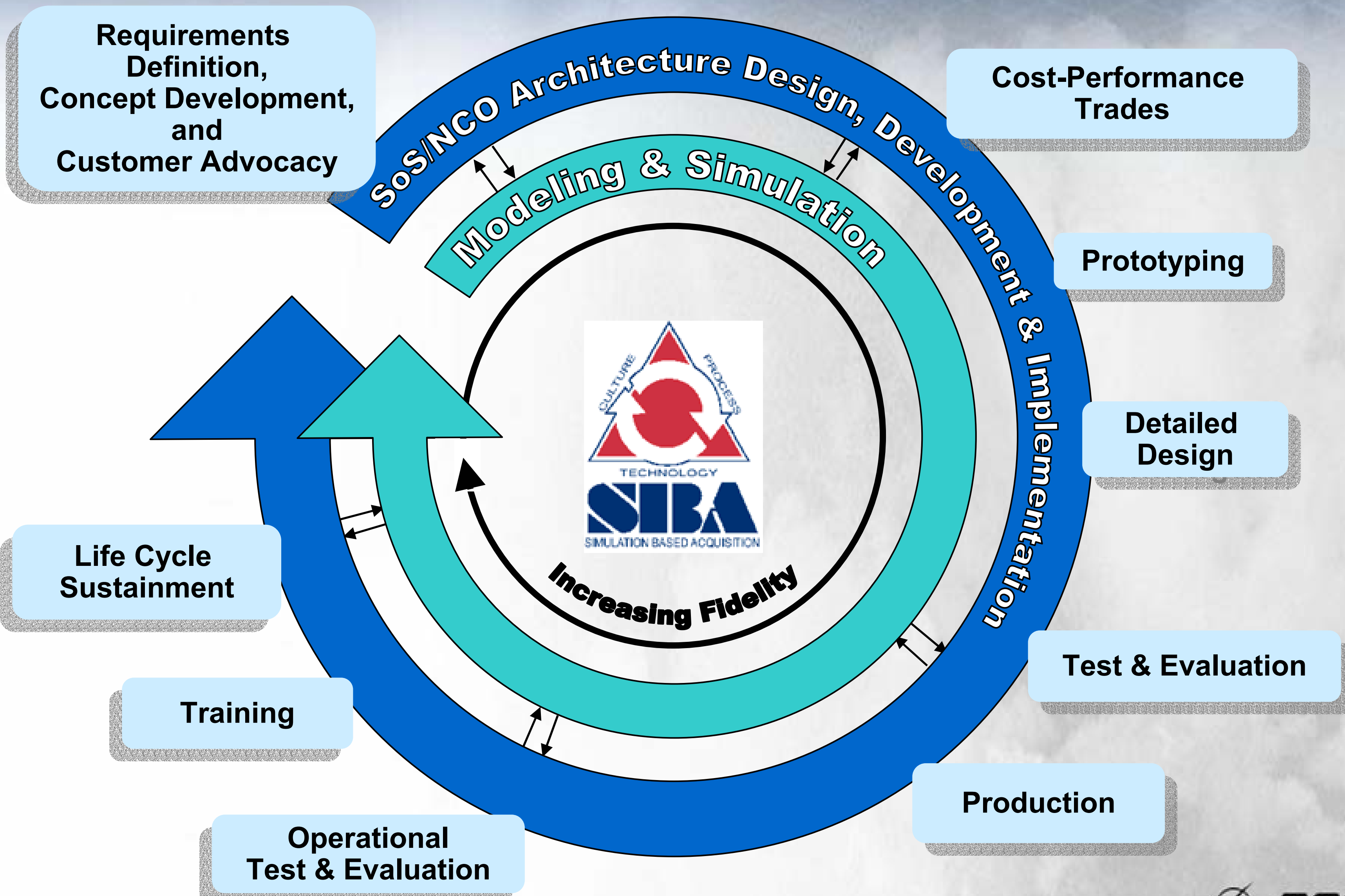
M&S isn't a nicety, but a necessity

Complexity drives the need for M&S



Complex Systems of Systems demand M&S in development process.

Roles of Modeling & Simulation



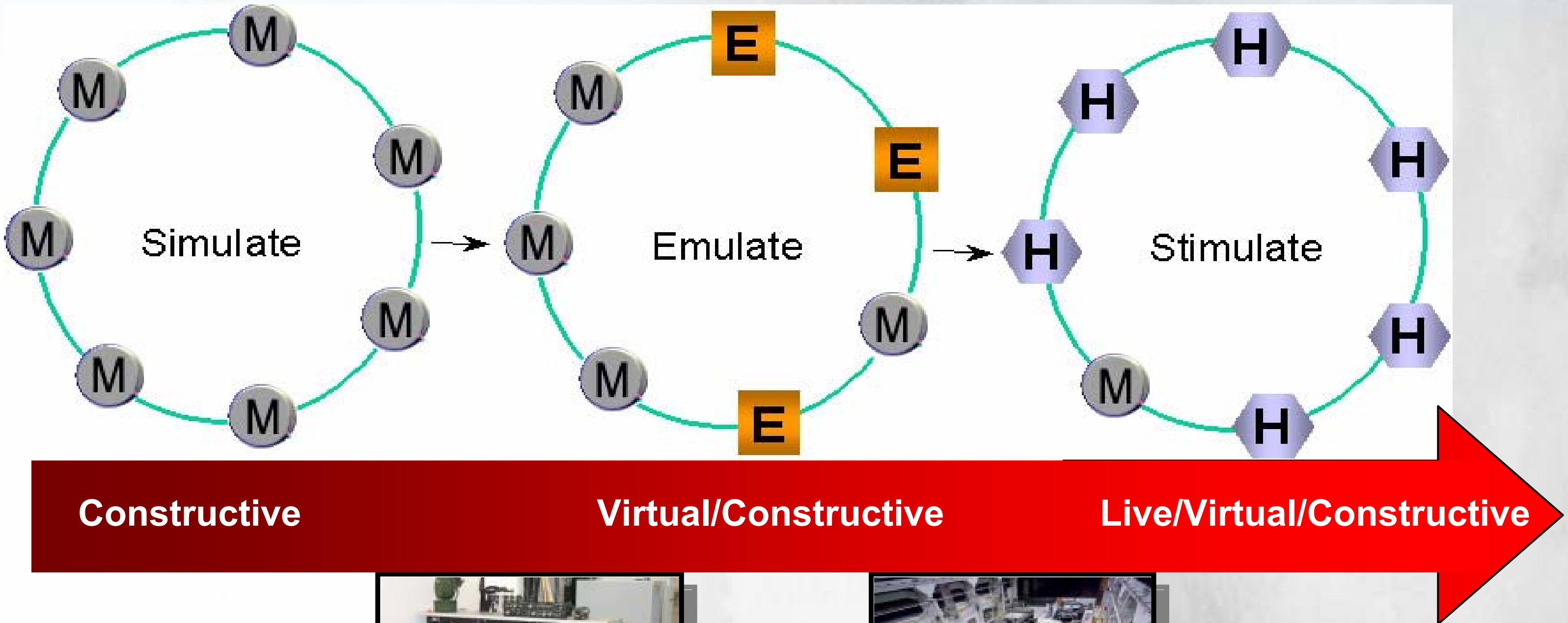
BOEING

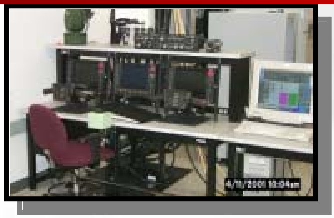
Building Block SoS Test Approach

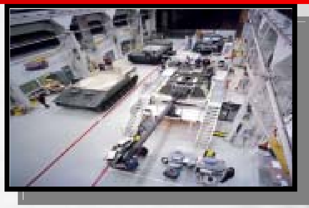
Systems simulated to comprise subset of SoS

System simulations upgraded and coupled with early emulations comprise subset of SoS with SoS interfaces

System simulations and emulators upgraded and coupled with prototype hardware to comprise SoS





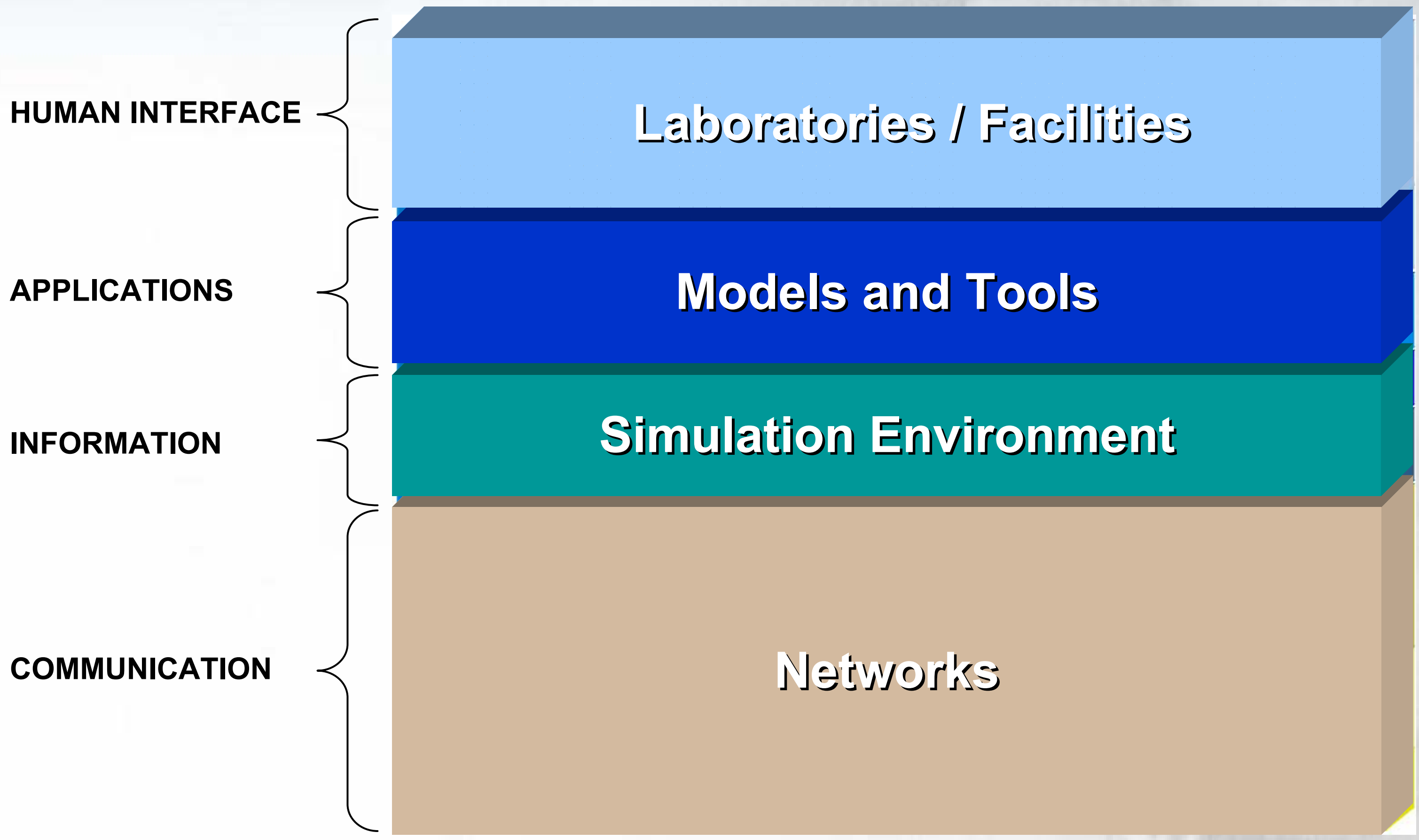


Early phases are simulation and emulation based to gain knowledge for Design & Development to set up for Test success

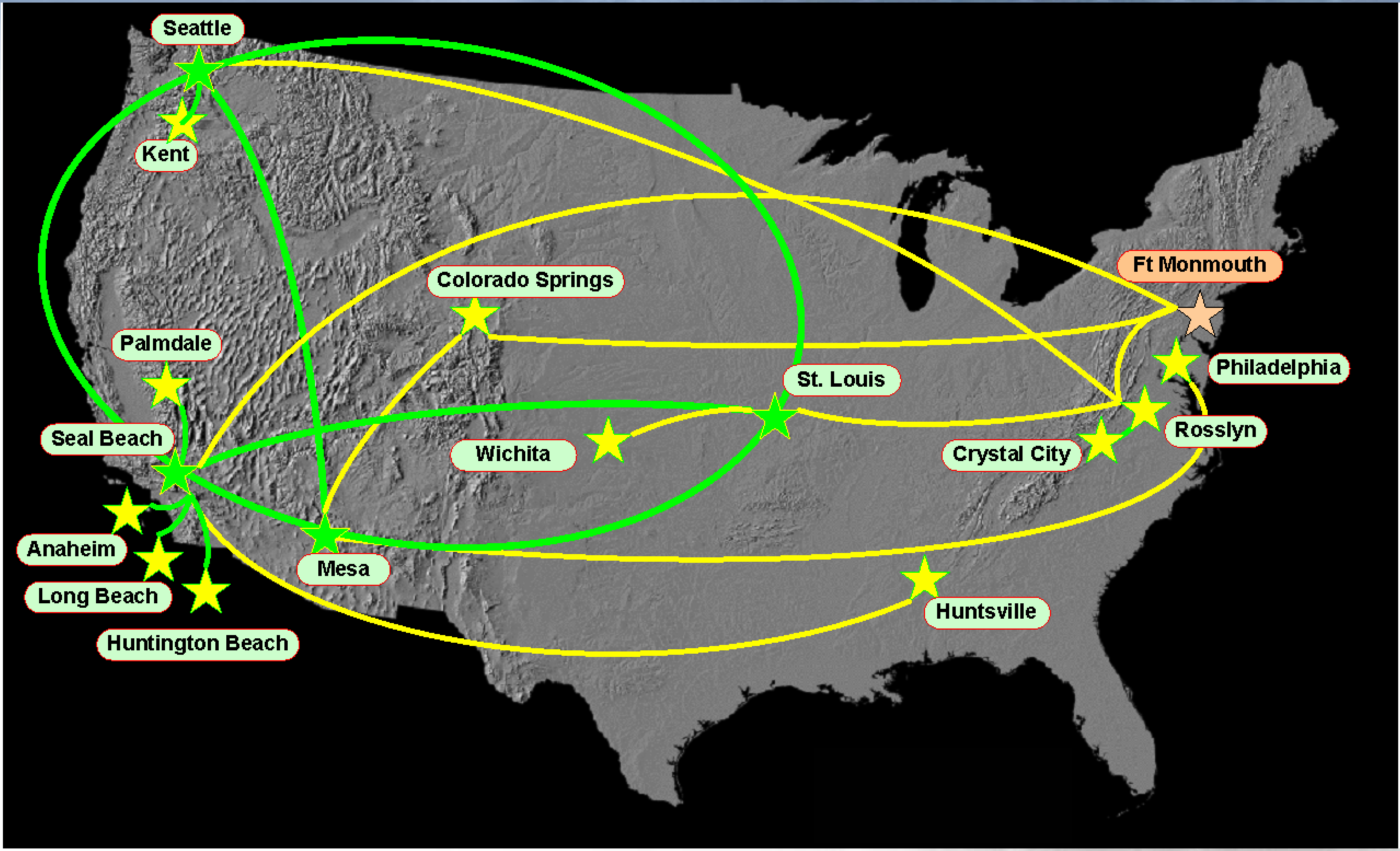
Organization Matters

- **Recognizing the value of M&S, Boeing recently formed an overarching modeling & simulation organization**
  - **Integrates organizations and functions that cross program boundaries, and**
  - **Provides analysis of network enabled systems of systems**
  - **All connected by one knowledge base**
- **M&S Infrastructure formed around NCO Industry Consortium architecture**

M&S Architecture



Boeing LabNet



Three Levels of Military Simulation

Level 1: Systems Level of War
Flight Sim., Mesa, ITDL ,VWC
Huntsville, Philadelphia, CoS

Level 2: Tactical Level of War
Virtual Warfare Center

Level 3: Oper'l Lvl of War
Boeing Integration Center

- Operators
- F/A-18; EA-18G
- Apache
- AWACS
- CRW
- SBR/Space Assets
- UCAV/UAV
- SHORAD
- Weapons

- Operators
- CONOPS/TTPs
- Systems-of-Systems
- Interoperability
- Tactical S&R/C2/BM

- Operators
- ADV NCO C2
- BMC4ISR
- Interoperability

BOEING

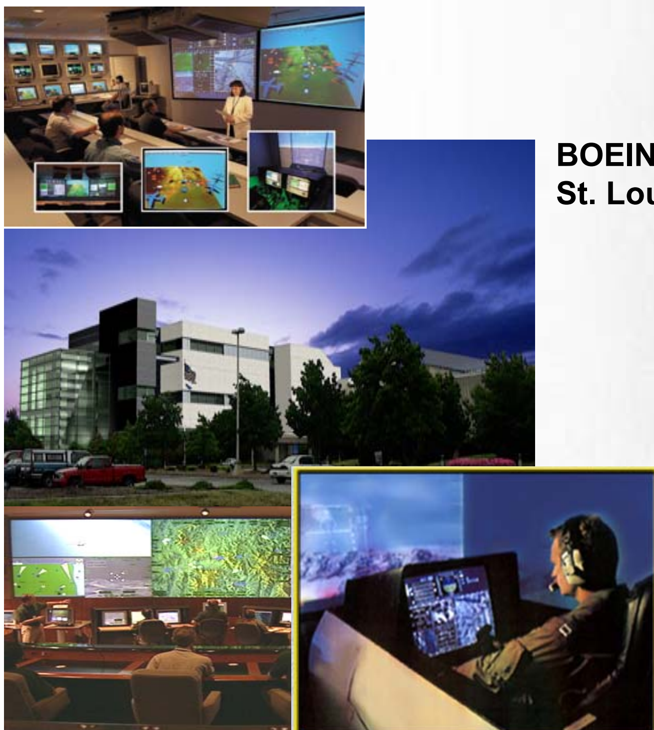
Virtual Warfare Center

- 65,000 square feet
- 23 SCIFs
- Dual operational capability
- Flexible network options
- Video-over-internet capability
- Ability to simulate more than 2,000 digital bodies
- Six F/A-18 cockpits, four F/A-22 cockpits, four F-15 cockpits
- Simulate such platforms as AWACS, AEGIS, Patriot and other ISR systems
- Various patent pending simulation technologies to expand scenario sizes

Government - Industry M&S Connection

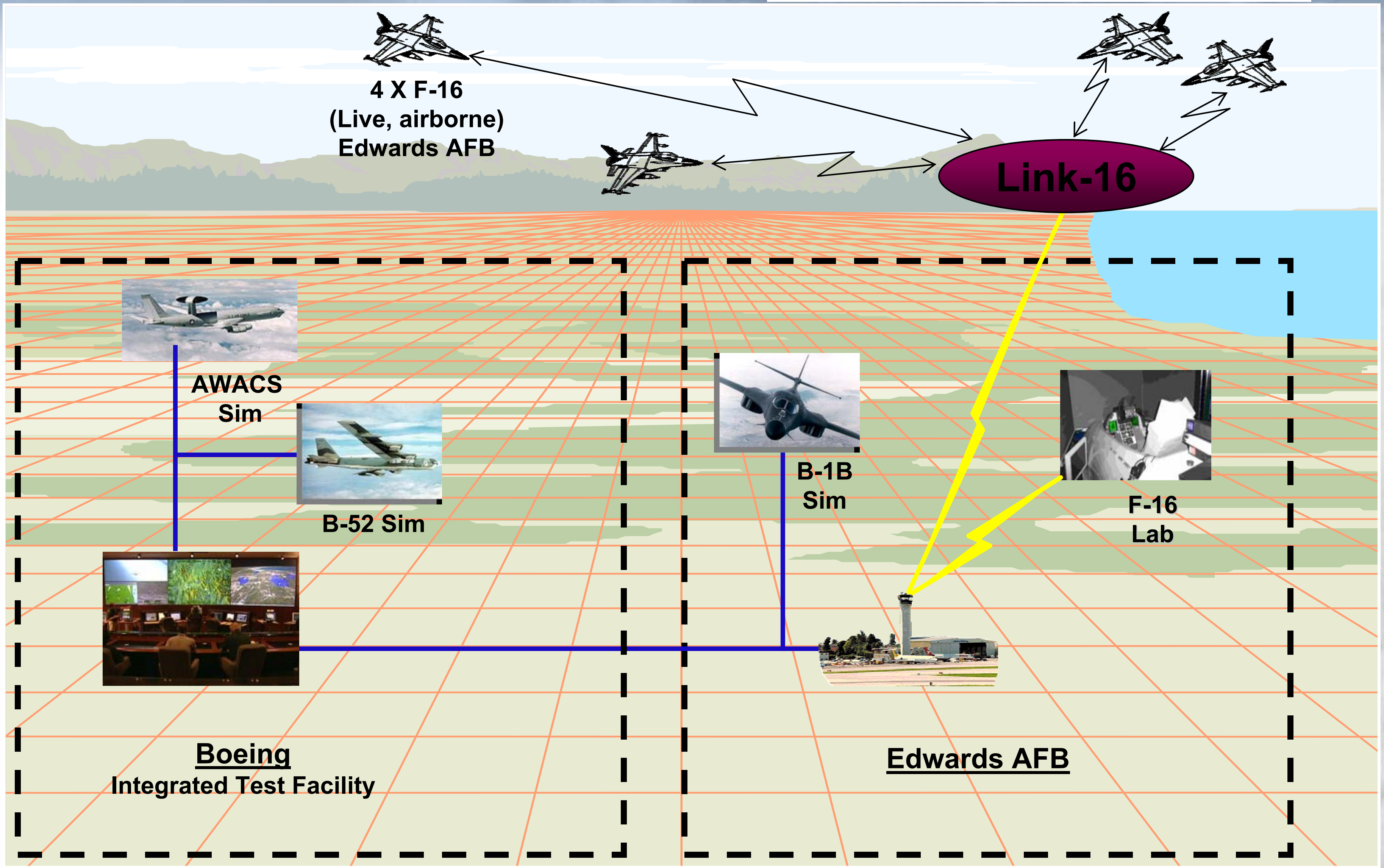
SIMAF
Dayton

BOEING
St. Louis



Live & Virtual Data Link Integration Demonstration – December 2005

Boeing Palmdale/AFFTC Edwards AFB



Impediments

- Zealotry
- Different goals
  - Programmatic
  - DT&E
- Intellectual Property
- Security

Notice the lack of technological impediments.

Summary

- **M&S is critical for successful DT&E of complex, net-enabled systems of systems**
  - **Requires robust application of M&S across the entire product life cycle**
- **M&S is available, today, to provide credible DT&E involving Live, Virtual, and Constructive elements**

Partnerships are key – both government/industry, and industry/industry.

M&S STUDIES IN THE CONTEXT OF T&E AND ACQUISITION

Diagnosis of the Problem: What Prior Studies Have to Say

22nd Annual National Test & Evaluation Conference
8 March 2006

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Presentation Outline

- M&S and T&E Background
- Overview of Prior Acquisition M&S Studies
- Selected Study Recommendations for M&S Related to T&E
- Some Common Themes in Acquisition M&S Study Recommendations
- Some Personal Observations on the Way Ahead

T&E and M&S: Definition Linkages

Test and Evaluation (T&E)

Process by which a system or components are exercised and results analyzed to provide performance-related information. The information has many uses including risk identification and risk mitigation and empirical data to **validate models and simulations**. T&E enables an assessment of the attainment of technical performance, specifications, and system maturity to determine whether systems are operationally effective, suitable and survivable for intended use, and/or lethal. …

Model

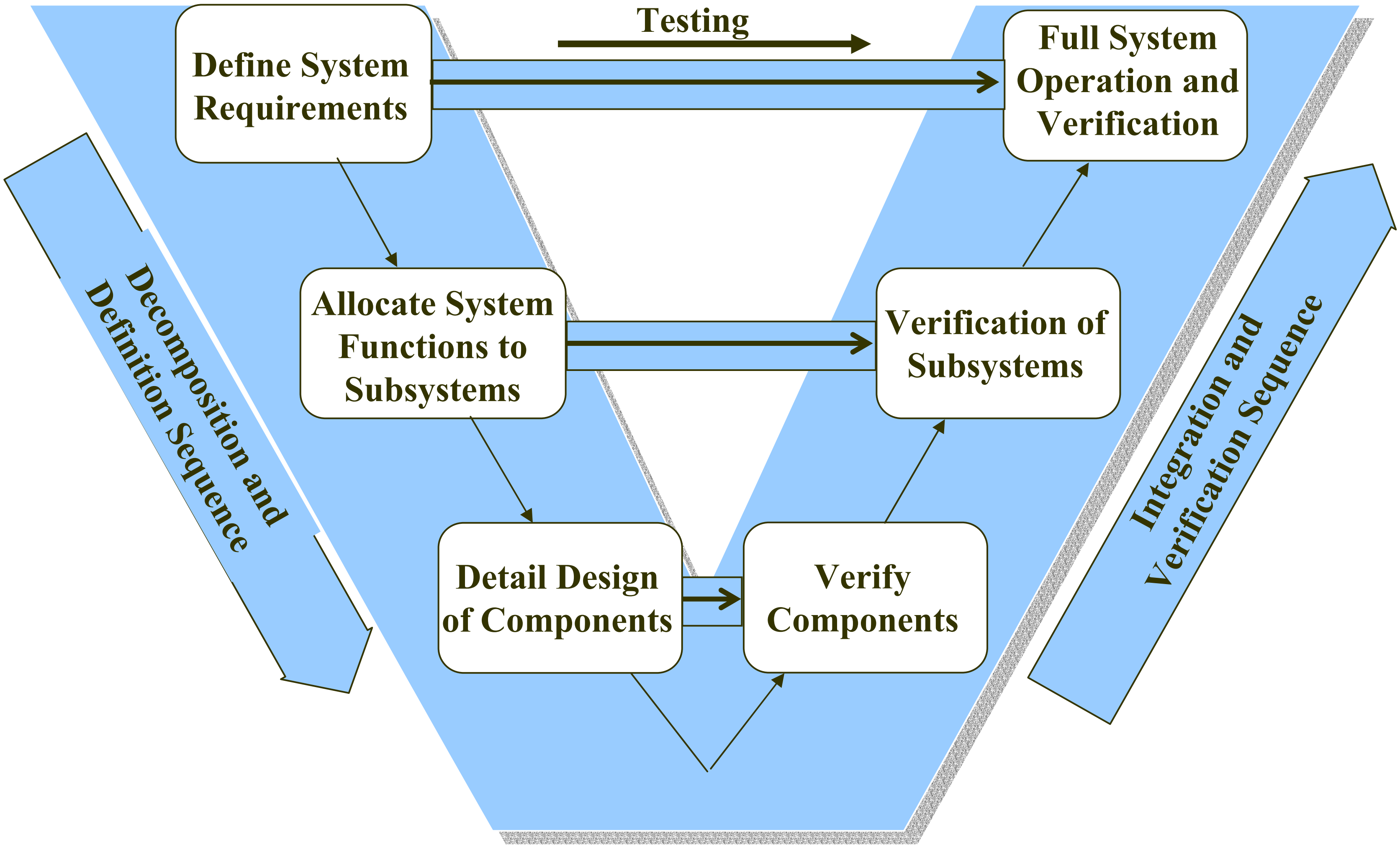
A representation of an actual or conceptual system that involves mathematics, logical expressions, or computer simulations that can be used to predict how the system might perform or survive under various conditions or in a range of hostile environments.

Simulation

A simulation is a method for implementing a model. It is the process of conducting experiments with a model for the purpose of understanding the behavior of the system modeled under selected conditions or of **evaluating** various strategies for the operation of the system within the limits imposed by developmental or operational criteria. Simulation may include the use of analog or digital devices, laboratory models, or **“testbed” sites**. …

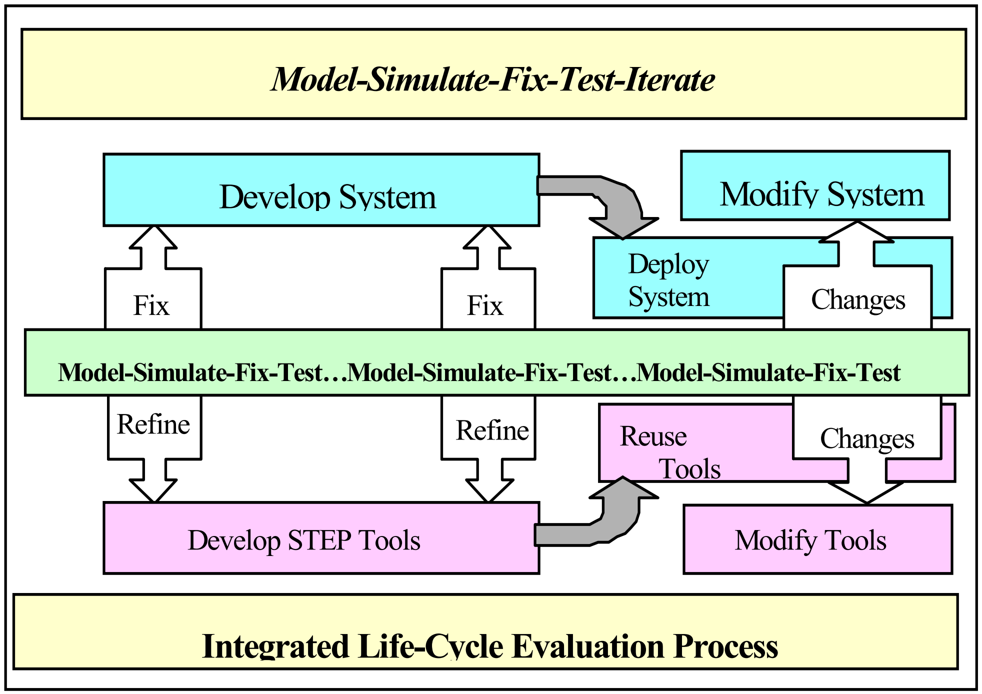
Source: Glossary of Defense Acquisition Acronyms and Terms, 12th edition, Defense Acquisition University, July 2005.

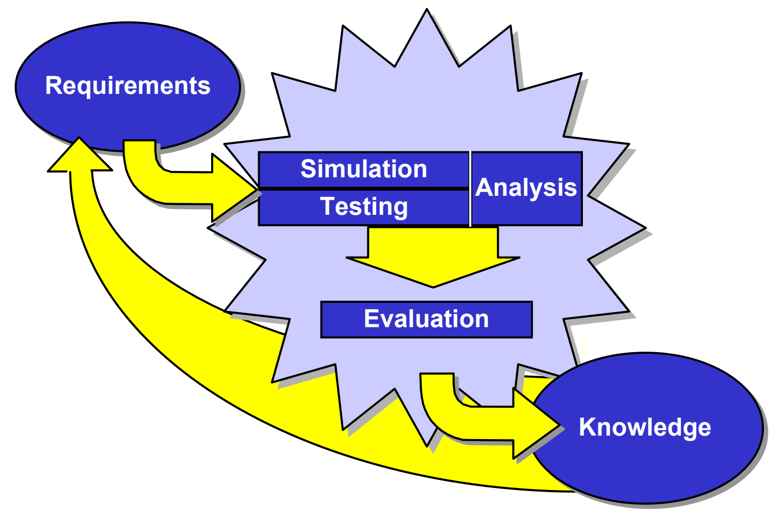
The “V” Process Model for Systems Engineering



Source: Benjamin Blanchard, Wolter Fabrycky, *Systems Engineering and Analysis*, Prentice Hall, New Jersey, 1998

One View of the Relationships among Modeling, Simulation, Test, and Evaluation





Source: *Simulation, Test, and Evaluation Process (STEP) Guidelines*, Director, Operational Test and Evaluation, and Director, Test, Systems Engineering and Evaluation, 4 Dec 1997.

A Decade of Acquisition M&S Studies (1 of 2)

1994	J	Final Report of the Acquisition Task Force on Modeling and Simulation (DDR&E)
	N	Naval Research Advisory Committee Report on Modeling and Simulation (NRAC/ASN(RDA))
1995	N	Collaborative Virtual Prototyping: An Assessment for the Common Support Aircraft Initiative (NAVAIR)
1996	I	Collaborative Virtual Prototyping Sector Study (North American Technology and Industrial Base Organization)
	I	Study on the Application of Modeling and Simulation to the Acquisition of Major Weapon Systems (American Defense Preparedness Association (ADPA))
	J	Study on the Effectiveness of Modeling and Simulation in the Weapon System Acquisition Process (DoD Director, Test, Systems Engineering and Evaluation)
1997	P	Technology for the United States Navy and Marine Corps, 2000-2035, Becoming a 21st Century Force, Volume 9: Modeling and Simulation (Naval Studies Board, National Research Council (NRC))
	J	Simulation, Test, and Evaluation Process (STEP) Guidelines (DOT&E and DTSE&E), December 4, 1997

Joint DoD (J) Navy-oriented (N) Industry-driven (I) Private organization (P)

A Decade of Acquisition M&S Studies (2 of 2)

1998	J	A Roadmap for Simulation Based Acquisition – Report of the Joint Simulation Based Acquisition Task Force, December 4, 1998
	J	Simulation Based Acquisition: A New Approach – Report of the Military Research Fellows, Defense Systems Management College, 1997-1998
1999	P	Advanced Engineering Environments: Achieving the Vision, Phase 1 (NRC – prepared for NASA)
2000	P	SIMTECH 2007 Mini-Symposium and Workshop Proceedings: Session 1, December 1997, and Session 2, August 1998 (Military Operations Research Society (MORS))
2001	J	Results of the DOT&E/LFT&E Survey of Modeling & Simulation
2002	P	Modeling and Simulation in Manufacturing and Defense Systems Acquisition: Pathways to Success, June 2002 (NRC – prepared for Defense Modeling and Simulation Office (DMSO))
2004	I	M&S Support to the New DoD Acquisition Process, February 2004 (National Defense Industrial Association (NDIA) Systems Engineering Division, Modeling & Simulation Committee)
2005	J	Acquisition Modeling and Simulation Master Plan (Preliminary Draft), Acquisition M&S Working Group

Joint DoD (J) Navy-oriented (N) Industry-driven (I) Private organization (P)

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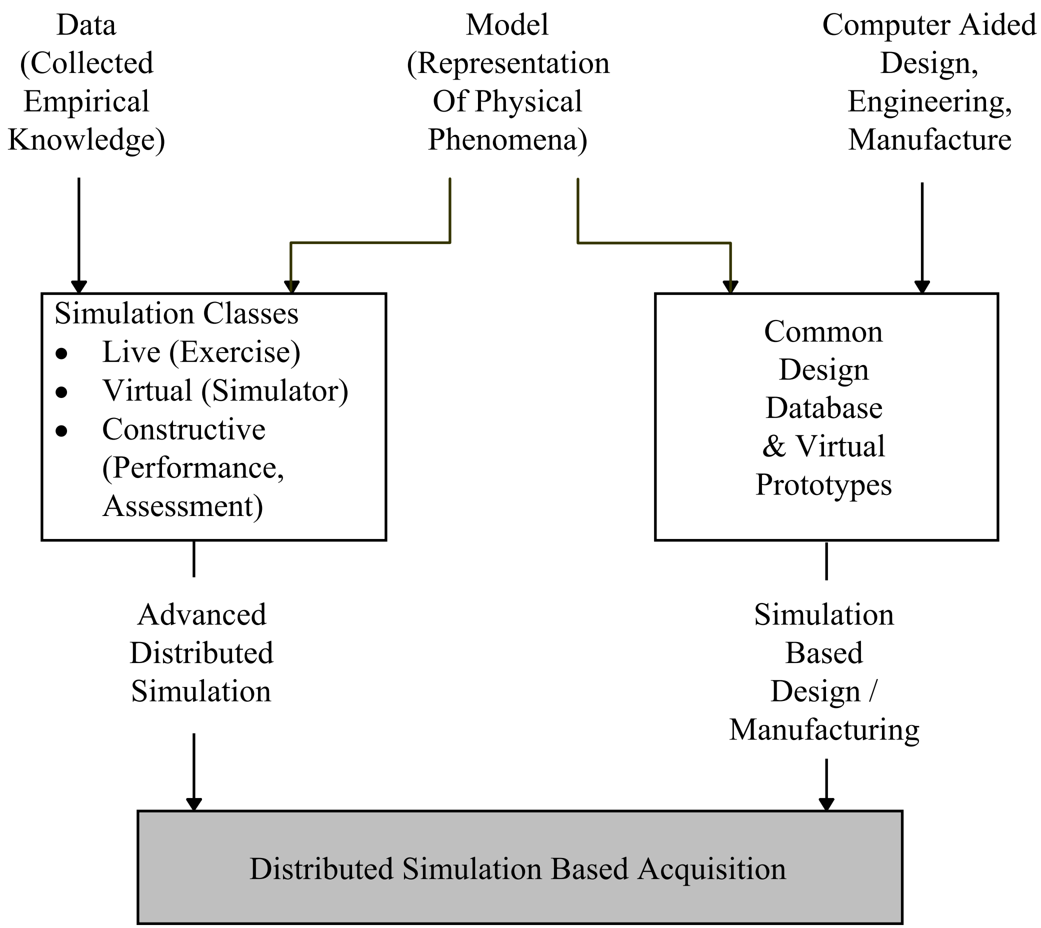
Naval Research Advisory Committee: Distributed Simulation Based Acquisition



Source: *Naval Research Advisory Committee Report on Modeling and Simulation*, NRAC 94-3, Nov 1994.

Study on the Effectiveness of Modeling and Simulation in the Weapon System Acquisition Process

October 1996

Final Report

Selected Finding / Recommendation from Study on Effectiveness of M&S in Acquisition (1996)

- The issue is, to what degree can M&S replace or augment field tests?
  - There is no universal answer, but the message received in part by the community is that the thought and guidance are there, but the implementation and acceptance are not.
- To meet the challenge of institutionalizing the use of available technology, the Services must be committed to **providing funds for modeling and simulation at the inception of the program**.
  - OSD and the Services should commit Science and Technology dollars to upgrade capabilities and facilities **that could serve many weapon system acquisitions**.
  - **Program managers should be encouraged to use these facilities** and capabilities instead of contracting to have their own system specific facilities and tools built.

Background / Motivation for Several DoD Acquisition M&S Studies in the late 1990s

DoD Simulation Based Acquisition
Vision Statement and Goals

Vision: **An Acquisition Process in Which DoD and Industry Are Enabled by Robust, Collaborative Use of Simulation Technology That Is Integrated Across Acquisition Phases and Programs.**

Goals: **The Goals of Simulation Based Acquisition (SBA) Are to:**

- **Substantially Reduce the Time, Resources, and Risk Associated With the Entire Acquisition Process;**
- **Increase the Quality, Military Worth and Supportability of Fielded Systems, While Reducing Total Ownership Costs Throughout the Total Life Cycle;**
- **Enable Integrated Product and Process Development (IPPD) Across the Entire Acquisition Life Cycle.**

Source: Acquisition Council of the DoD Executive Council for Modeling and Simulation (approved 5 Dec 1997).

Some Sound Bites from the STEP Guidelines: M&S and the TEMP

SIMULATION, TEST, AND EVALUATION PROCESS

STEP

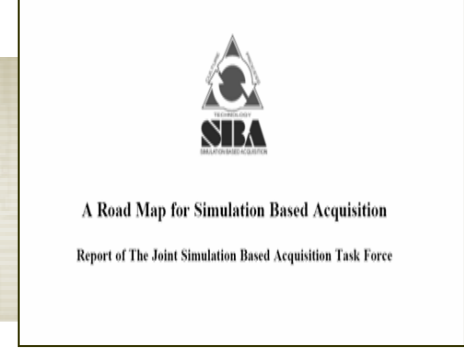
GUIDELINES

4 DECEMBER 1997

The TEMP should

- document how the early use of M&S will aid in assessing vulnerability and lethality
- address STEP resources that will help identify areas where data is needed and where M&S development is needed
- identify areas where actual testing either can be augmented by M&S or used to validate the models and simulations
- summarize the M&S VV&A and the data certification to be conducted
- reflect the integration of models, simulations, and test events to obtain the most credible data with which to conduct a comprehensive evaluation of performance
- include a discussion of the mission-level and engagement-level models and simulations, that will be used to identify COIs and the operationally significant MOEs and MOPs, so CTPs can be derived
- document how the early use of M&S will aid in assessing the operational impact of suitability issues (the "ilities") and logistics, and in determining initial tactics, training, and procedures
- document the integrated use of accredited models and simulations with OT to increase the knowledge and understanding of the capabilities and the limitations of the system as it will be employed
- include the resources required to VV&A the models and simulations; the resources required to obtain, maintain, and M&S; and the resources required to archive data for the M&S

Some Recommendations from the SBA Roadmap (1998)

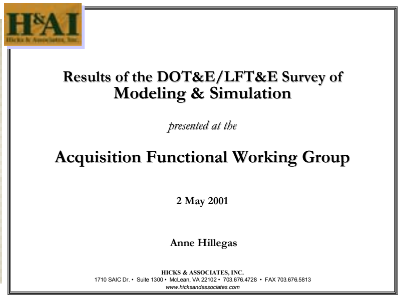

SBA

A Road Map for Simulation Based Acquisition

Report of The Joint Simulation Based Acquisition Task Force

- Short Term:
  - The T&E community should **develop additional Deskbook practices** addressing the specifics and actual examples of M&S integrated with T&E in the evaluation strategy (layer of detail more specific than **Simulation, Test, and Evaluation Process (STEP) Guidelines**).
    - Criteria for accepting verification and validation (V&V) for models to be accredited by the T&E community should be addressed
    - Practices and procedures should also include techniques regarding the pooling of test data with simulation data, and associated limitations.
  - Continue to fund and support **development of virtual T&E infrastructure** to include synthetic test environments, virtual firing ranges and proving grounds, etc.
- Long Term:
  - Review OT and Live Fire Testing policies with respect to M&S as technological advancements occur (and M&S capabilities improve) to determine if **changes to legislation** should be proposed.
  - Continue efforts to evolve and advance **virtual T&E infrastructure**.

Selected Recommendations from DOT&E / LFT&E Survey of Modeling & Simulation (2001)


H&AI
Hicks & Associates, Inc.

Results of the DOT&E/LFT&E Survey of Modeling & Simulation

presented at the

Acquisition Functional Working Group

2 May 2001

Anne Hillegas

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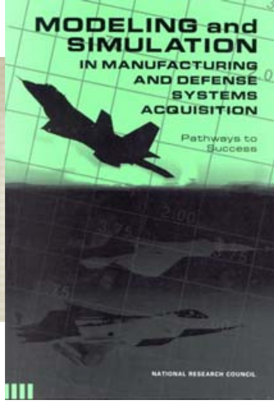
www.hicksandassociates.com

- Emphasize the important role that acquisition programs must play in the development of M&S
  - address M&S in the 5000 series
  - **incentivize Program Office investment** in M&S
- Foster an improved understanding of the interrelationship of T&E and M&S
  - **Endorse pilot programs** with the SAEs that examine and demonstrate the utility of M&S for T&E

Some Sound Bites from the NRC M&S in Manufacturing and Acquisition Study (2002)



- “It will therefore be necessary to create and sustain an acquisition infrastructure, including an M&S infrastructure. DOD acquisition personnel could use M&S to predict the cost-effectiveness of potential solutions, thereby **reducing the need to produce and test expensive hardware prototypes**.”
- “The **desire to achieve and maintain interoperability requires** early and continuing commitment to several orchestrated activities. These include development of **common standards, protocols, and data definitions**; agreed-upon concepts of operation; testing and evaluation to ensure that agreed-upon actions have been implemented properly; and configuration management of systems to assure proper management of evolutionary changes.”
- “Task Force XXI demonstrated two important acquisition needs: first, the significance of coevolving the system-of-systems with continual dialogue among all major stakeholders; and second, the **need for a virtual M&S testbed** to enable this dialogue.”
- “As M&S is used more in operational testing, the **demands on the validation of the simulation will increase**. … Validation methods that quantify the bounds of validity and risk of error in a model can help to establish the limits of M&S applicability in operational test and evaluation.”

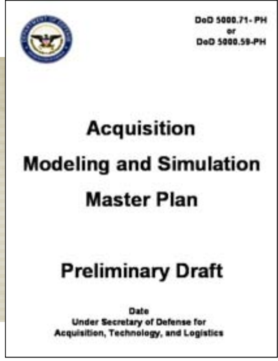
Selected Findings from the NDIA Systems Engineering M&S Committee Report (2004)

National Defense Industrial Association
Systems Engineering Division
Modeling & Simulation Committee

Study Task Report
M&S Support to the New DoD Acquisition Process

- Distributed simulation offers a practical, cost-effective way to integrate and test systems of systems.
  - **Rounding up all the actual hardware** to compose an entire system of systems for integration and/or test **becomes increasingly impractical** as the number of systems in an SoS grows.
- Substituting *credible* simulations for the real weapon systems not under test offers an optimal way to integrate individual systems
  - It is flexible, scalable, and **protects proprietary/intellectual property**.
  - The capability to intermix simulations, real systems, and lab assets (“hardware in the loop”) in a distributed simulation federation has been repeatedly shown to be both feasible and helpful
- A promising example of the above approach is the Joint Distributed Engineering Plant (JDEP), but it is currently **under-resourced**.
  - A non-proprietary, tailorable, reasonably-available family of such federations would go a long way toward providing the **‘standard’ environments** needed to explore the time-coordinated, dynamic interactions of an SoS.
- The existence and **adoption of open standards** can allow M&S tools to be flexibly used together to address the challenges of the new acquisition process.

Some Recommended Actions from the Acquisition M&S Master Plan (Preliminary Draft, 2005)


DoD 5000.71-PH
or
DoD 5000.59-PH

Acquisition
Modeling and Simulation
Master Plan

Preliminary Draft

Date
Under Secretary of Defense for
Acquisition, Technology, and Logistics

- Establish policy to **require documented M&S planning** at the joint capability & program levels as part of the Systems Engineering Plan, **T&E Strategy and T&E Master Plan**
- Establish **policy on appropriate use of M&S to plan tests, to complement system live tests**, and to evaluate joint capabilities
- Establish a forum to clarify the characteristics and application of various **distributed simulation standards** (HLA, TENA, DIS, SI3, etc.); examine opportunities for convergence
- Enable readily-available distributed **live-virtual-constructive environments**, leveraging related initiatives
  - Establish DoD-wide **standards** for distributed environments
  - Make candidate simulations, labs and ranges compliant with these standards
- **Centrally develop and maintain** high-priority, broadly-needed M&S tools

Source: "Report of the Acquisition M&S Working Group regarding an Acquisition M&S Master Plan," J. W. Hollenbach, 2005 Fall Simulation Interoperability Workshop, Orlando, FL, Sep 2005.

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Some Common Themes in Acquisition M&S Study Recommendations

- That M&S can reduce T&E costs seems intuitive and is accepted
- Need for cross-program M&S capabilities (but how to fund them?)
- Need for "virtual" testbeds (again, how to fund them?)
- Need for open M&S standards (applications, data, …)
- Concern for proprietary data / intellectual property
- Need for education of acquisition community in M&S
- Recommendations for pilot programs (but few ever funded)
- Need for incentives to use M&S (but few, if any, actionable ideas)

A combination of technical, process, and culture issues remain

APL

Some Personal Observations on the Way Ahead

- As cross-cutting enterprise-level functional disciplines in the acquisition process, M&S and T&E have to work together
  - *“If we don’t hang together, we will surely … ”*
- M&S standards supporting T&E need to be “harmonized” to better support multi-Service, Joint and coalition T&E
  - *HLA … TENA … DIS …*
- A way must be found to fund “common good” M&S-in-T&E activities that support multiple programs across Services
- A consensus-based process should be initiated to develop an M&S-in-T&E Recommended Practices Guide (RPG)
  - *Use DMSO’s DoD M&S VV&A RPG development process as an exemplar*
- Be cognizant of the recommendations of prior studies, how they were received, and what results they achieved
  - *“Those who ignore history are condemned to repeat it.”*

Prepared Remarks

Modeling, Simulation and Testing: Collision Course or Happy Marriage?

Philip E. Coyle

March 7, 2006

NDIA 22nd Annual National Test and Evaluation Conference

Hyatt Regency Jacksonville

When I chose as a title for my remarks - *Modeling, Simulation and Testing: Collision Course or Happy Marriage?* - I didn't know I would be following Gen. Larry Welch, always a daunting prospect. Gen. Welch probably knows more about modeling and simulation than any general officer who ever lived. I look forward to every opportunity I have to hear him speak. I've never known anyone who can move from the highest level policy issues down to the individual warfighter with more insight and clarity. Gen. Welch moves with ease from 40,000 feet altitude down to ground truth, and anywhere in between, and he always makes great common sense, as he has again this morning. Mark Twain said "Common sense is not so common," and Gen. Welch proves how true that is. He also made great common sense in a recent DSB study, which I'll come to in a minute.

When I chose my title for this talk, I also didn't know that Admiral Bert Johnston would be giving a talk on Wednesday titled "Open Air Testing vs. Modeling and Simulation: At Last Peaceful Coexistence?"

So before you decide whether you like what I have to say, you'd better wait for Admiral Johnston's talk, as well.

Expectations for M&S - DOD vs. DOE - the differences and the reasons
But to get back to the marriage between modeling, simulation and testing, I've always been puzzled by the fact the M&S is so problematic in the DOD family. In the DOD, M&S kind of nibbles around the edges, which I suppose is alright if that's all the DOD wants, but the DOD and the Services regularly make high sounding pronouncements that M&S is going to be the answer and the greatest thing since sliced bread. While we will hear during this conference examples of excellent M&S work, it is not easy to find examples in the DOD where M&S has really made a difference.

Some of you know that I came to the Pentagon from the Lawrence Livermore National Laboratory where modeling, simulation and testing was - and still is - a very happy marriage. We never did a test without first trying to calculate - model, as you would say - in rather excruciating detail what would happen. It was literally unthinkable that you would spend millions of dollars on a test without making an equivalent effort first in M&S.

For the most part, the DOD does not do that. It's quite common in the DOD to spend millions of dollars on a test without making any significant investment in M&S first. An area of some exception is Live Fire testing, about which I'll say more later.

Nevertheless, I came to the DOD fully prepared support M&S, and did so throughout my tenure at the DOD. But the support I gave to M&S, and the support that Undersecretaries for Defense for AT&L and many other senior leaders have given to M&S, has made very little difference. This is especially surprising since the computational tools that are available today are so much more powerful than they were ten or twenty years ago. Nevertheless, DOD practices haven't changed much. I think there are at least four reasons for this.

First, the focus in DOD defense acquisition is on buying something and moving on, not on understanding for its own sake. Understanding is important, of course, you can't field a system without understanding it, but detailed scientific and technical understanding - both broad and deep - is not the first priority. By contrast, the culture in the development of nuclear weapons has been to achieve first-principles understanding of everything. It's a good thing, because today full-scale underground nuclear testing is no longer permissible. Without those models, the Department of Energy weapons labs would be quite helpless today.

Second, program managers don't want to spend money on M&S if they don't have to. PMs have many demands on their resources, and the incentives are to get the system into production with as little perturbation as possible. In the Department of Energy (DOE) family it is assumed that you will spend money on M&S, lots of money, and it is budgeted every year, year after year, with no expectation that you will <u>ever</u> be finished. Further, in the DOE family there is no expectation that you can trade off M&S for testing; they go together. So there is no PM who is trying to cut testing by spending money on M&S.

Third, the goal for modeling and simulation in the Department of Energy family is to be able to predict with rather astonishing accuracy what will happen. Dr. Keith Bradley will show some examples in his talk Thursday afternoon. While no model is ever perfect, the goal is to come as close to reality as possible, and often the DOE Labs get very close to that goal. This means that modeling and simulation, and the evaluations that come from those models, may produce bad news.

By contrast, in the DOD, the tendency is to expect that test and evaluation will produce bad news and that M&S will produce <u>good</u> news. Thus M&S is often recommended as the better choice, not only because it might supplant testing, but because - generally - the expectation is that M&S will produce better news. Of course, this good news may not have anything to do with reality, especially if the models being used were first developed - as is often the case - to sell the system, not to understand it in technical detail.

In the DOE Labs, a model may produce very bad news, bad news that you have to take very seriously because the model has been doing a pretty good job of predicting reality. That bad news may not <u>actually</u> <u>be</u> bad news, as subsequent tests may reveal, but unless M&S and testing work together, you won't know for sure.

My point is that in the DOE Labs, the intent is that the models will capture the real world, just as tests are trying to capture the real world. Where does a model or simulation get its inputs? Often from test results. How are the test results to be interpreted and understood? Often through modeling and simulation.

Thus, in the DOE Labs, M&S and testing are partners that go together with more or less equal likelihood of providing realistic insights. To get to the bottom of the questions M&S and testing both raise, it is necessary to iterate, back and forth, between the models and live tests.

This iterative process is essential for a healthy M&S program. Accordingly, in the DOE Labs if a model produced bad news, you wouldn't just change the model so it produced happier results, and then stop. This is something I've seen done in the Department of Defense. If a model produces bad news, you shouldn't just change it; you need to understand <u>why</u>! Maybe the problem is real. And to find out takes an iterative process that essentially

never ends. This type of sustained, iterative process between M&S and testing is not very common in the DOD.

Fourth, it is more difficult in the DOD to identify a manageable set of M&S programs and goals. You can't model everything - any more than you can test everything - and DOD systems are often so complex that the number of areas where one could conduct M&S is mind numbing.

In short, in the DOE nuclear weapons family there is really only one overall mission supported by a relatively small number of programs, whereas in the DOD family there are many missions and hundreds of programs.

Recommendations - Four Steps for Change

So to establish a happy marriage between M&S and testing in the DOD it's going to take several new things:

First, DOD leadership will need to make larger and sustaining investments in M&S that are not tied to earlier full-rate production dates or reduced testing. DOD investments are needed in M&S for its <u>own</u> sake. This doesn't mean that M&S won't have to meet programmatic goals. Of course it must. But so long as it is a zero sum game, where a dollar spent on M&S is expected to save a dollar on testing, M&S and testing will have no more than a shotgun marriage relationship, at best.

Second, M&S will have to be supported by an iterative process from continuing and ongoing testing. Some of these tests will be conducted primarily to support M&S, and thereby understanding, not necessarily to support a programmatic milestone. And it also means that the DOD will sometimes get bad news from M&S, and when it does it cannot react by canceling the M&S, or cutting its budget, or cutting its reach.

Third, to make these investments manageable, the DOD will need to focus on mission areas, not programs. Here is where the DSB report that Gen. Welch co-chaired with Bob Herman is important. That report - the DSB Summer Study on Transformation - points out that the DOD must discipline its resources to <u>mission</u> purposes. Under the current approach, DOD always has many more programs all fighting for dollars than it can afford - the bow wave effect in "a sea of force provider interests". The DSB Summer Study recommends - among many other things - allocating resources to mission purposes, constraining plans to intended resources, and measuring progress

against plan objectives. The DSB study also recommends - for the reasons Gen. Welch explained a few minutes ago - limiting "the first stage of spiral development to designs providing: A useful increment of added military capability where there is no more than moderate risk in achieving cost, schedule and performance goals."

Measuring progress against plan objectives, and measuring risk requires modeling, simulation, test and evaluation, all working together.

In this regard, Live Fire testing is an area where M&S practices have been laudable. I don't know how DOT&E does it these days, but Jim O'Bryon used to insist that a Live Fire test <u>not</u> be conducted until it had been modeled first. I thought this was a very important policy and supported him in it throughout. He didn't always get what he wanted. Sometimes the M&S work was poor or half-hearted, sometimes the Services just wanted to do the test and get it over with, but Jim tried to instill in Live Fire testing a partnership with M&S, a relatively happy marriage.

In this sense you could think of Live Fire testing as a kind of "mission" area. Metal hitting metal is something that has to be expected with most battlefield systems, and so you could think of Live Fire testing as something common and overarching individual programs. Often the details in Live Fire tests might be quite common between programs that were otherwise quite different. It is in this sense that one can think of Live Fire testing as a "mission" area not unlike the context in which the word "mission" is used in the DSB report, although they are referring to mission areas in an operational warfighting context. And in this sense one can imagine organizing and managing M&S efforts along mission lines, as well.

My only point here is that by focusing on mission areas - not necessarily individual procurements - just as the DSB report recommends, M&S <u>also</u> could better manage the dazzling array of tasks it might undertake.

The emphasis in the DSB study on increased oversight and measuring risk, brings me to a fourth needed step. To adequately measure risks, the DOD will need to improve its understanding - broad and deep - of the mission area systems it intends to field. This new emphasis on understanding - so as to truly understand the risks involved - will be good for M&S also, and will produce a climate where understanding - not just procurement - is valued for its own sake.

The Defense Acquisition Performance Assessment Report
Having mentioned how helpful I believe Gen. Welch's DSB report on Transformation can be - not only to our overall military establishment, but by extension to how we think about M&S in the DOD, I need to comment on the Defense Acquisition Performance Assessment Report, which came out last month. The DAPA report, so called, complete with glossy cardboard cover and a set of cardboard "3-D" prism glasses such as seen in science fiction movies in the 1950s, is neither effective nor suitable. What the "3-D" glasses are for is a mystery, the DAPA links to their web sites don't work, and the little prisms at the bottom of each page don't shed any light on the real problem.

In fairness, the DAPA report points out that over the years there have been 128 separate studies of DOD acquisition performance, this being the 129th - and does quote others to identify certain problems. On its front page, the DAPA report quotes two recent Acquisition Policy reports by the Congress. The first from the Senate says," Problems occur because the Department of Defense's weapons programs do not capture early on the requisite knowledge that is needed to efficiently and effectively manage program risks."

The second quote from the House says, "...that the current Defense Acquisition Framework is not appropriately developing realistic and achievable requirements within integrated architectures for major weapons systems based on current technology, forecasted schedules, and available funding…"

The Congress clearly understands the problem. So does the GAO who reported way back in 1971 that "untested and undetermined technology risks" and "poorly defined requirements" were two major factors why DOD acquisitions so often failed. Of course the GAO has pointed this out countless times since 1971, also.

However, the DAPA report does NOT own up to the principal problems already well identified by the Congress or the GAO.

While the DAPA report makes 1,069 recommendations in 42 issue areas, most prominently, the need for improved oversight, it never addresses the

problems with risk that the Congress, the GAO, and Gen. Welch's DSB report address so clearly.

How can this be, you ask? In this issue area - the need for improved oversight - the DAPA report made more recommendations than in any other issue area. Yes, but instead of recommending mechanisms to strengthen oversight and the understanding of risk - such as earlier and more rigorous testing, and concomitant efforts in M&S, - the DAPA report recommends constraining oversight, and constraining the scope of OT&E, operational test and evaluation, which is hardly the problem when it comes to understanding risk.

If in the DOD, M&S actually identified risks, as I am recommending, the DAPA report probably would have recommended constraining M&S as well. Thus the DAPA report, if implemented, would be bad for the future of M&S and the larger role M&S could play.

In addition to being silent on addressing risk and technological maturity, the DAPA report does little to address the incentives needed to change behavior. You all know that incentives are what drive any process, and a lack of incentives is part of the reason why modeling and simulation is so different in the Department of Defense than in the Department of Energy.

Also, the DAPA report does not address the many problems in contracting that come from an inability of the government to get needed information.

This latter point often comes up in an M&S context where contractor models - originally developed to <u>sell</u> a system to Congress and to senior DOD and Service leadership - are treated as proprietary under many contracts even though those models are then used, sometimes misused, in the development of a system.

So unless you want to give the 3-D glasses to your kids, I wouldn't waste your time on the DAPA report.

M&S and Testing - Sharing the Same Goals
Jack Krings has spoken candidly about these things at many conferences. And Tom Christie has spoken and written about them as well. In the February, 2006, issue of Naval Institute Proceedings Magazine, Tom Christie has published a wonderful article titled, *What Has 35 Years of*

Acquisition Reform Accomplished? If you haven't seen his paper, I recommend it. As Tom explains so well, in system after system - time after time - the front end of the acquisition process sows the seeds of future problems. To quote Tom, "…by the time technical and cost issues come to the fore in spades, few, if any, of those involved in the process can bring themselves to admit they were wrong, to cut their losses before inevitable further cost growth and schedule slips, or to demonstrate much needed discipline by making an example of program officials and their contractors who have sold the department and the taxpayer a bill of goods."

Tom points out that what is needed is discipline, exactly what Gen. Welch's DSB report on transformation also recommends. And modeling and simulation can be part of that discipline in the DOD, just as it is in the DOE.

Like all successful marriages, for modeling, simulation and testing to be a happy marriage they have to share the same goals - namely to understand how a system really works, its strengths and weaknesses, and whether the system will be effective and suitable for the warfighter. The purpose of M&S and testing together is to produce insight and understanding. You all know from your own work that when you can measure a result in a test, and then calculate - model - that same result from first principles, that's when you feel you really understand it. You may still have many questions, but you know you are better off than you would be from either testing or M&S alone.

Conclusion

The future of M&S in the Department of Defense will be determined by the goals that are set for M&S. The relationship between modeling, simulation, testing and evaluation will be determined by those goals also. With the computational tools that are available today, there is no longer an excuse for the DOD to expect so little from M&S.

If M&S is going to continue to only nibble around the edges, if M&S is going to be viewed as a source for good news and never for bad news, and if M&S is thought of as a way to cut or avoid testing, then peaceful coexistence may be the best we can hope for. For M&S to not just nibble around the edges, transforming leadership is needed as Gen. Welch calls for.

But if M&S adopts the goals of true understanding, and providing evaluations that both require and complement testing, then a happy marriage

will result. To make a difference to the warfighter, both M&S and testing have to deal with the real world. Testing already does that. It's time that M&S did too.

Thank you.

DT&E's Perspectives on Making M&S and T&E Better Partners

Panel Summary

7 March 2006

Summary of Questions

Question Category (becomes an Issue)	# of Questions that fall into Category	Potential Activity to Address Issue	Priority	Actionee
Acquisition (Potential issue to address from these questions is development of a Test Strategy White Paper for Programs to leverage)	6	System vs. Capability Focus. Industry involvement in live-virtual system development. Difference between M&S Mast Plan and Sim Supp Plan. Motivation for PO to perform joint events in SDD with risk from uncertain models? (Funding for Multi-Service events?) Can DoD streamline acquisition process using M&S as enabler?		
Definitions	1	M&S Savings Metrics.		

Summary of Questions

Question Category (becomes an Issue)	# of Questions that fall into Category	Potential Activity to Address Issue	Priority	Actionee
Re-use	2	Manage re-use of DT&E and M&S assets through program life-cycle and/or across DoD Programs.		
Partnerships	3	List of avail M&S. Confidence of sims that model sub-systems of “other” contractors (Intellectual Property?) National/International Society supporting M&S		

Introduction
Mr. DiPetto

- Testers need to assist PMs to develop M&S strategies
- Ensure Accreditation in addition to V&V
- M&S must support T&E and SE
- M&S is only practical means of SoS capability testing
- Use Model – Test – Fix – Model approach
- Many cross-cutting issues exist that are beyond the reach of PMs & testers; OSD is addressing

Dr. Kai'liwai
AFFTC

- How does DT&E use M&S data in testing today?
  – Is M&S used to help determine how much testing is enough?
  – Are M&S data used to improve DT&E?
- How does the DT&E community feed test data to M&S community, and vice versa?
  – Are test data used to refine M&S Models?
- How is DT/M&S community working together in NCO/W?
  – Are there lessons learned that can apply to DT&E/M&S communities elsewhere?

Mr. Berard
WSMR

- Data Management
  - Cross Domain (class/unclassified) solutions
  - Access/Distribution Across the Distributed Domain
- Integrated Joint Processes (Data, Architecture, Models, Control, Scheduling)
- Enforcement of DoD standards and directives
  - Joint Testing Policy
- Configuration Management
  - Document Management, Networks, Applications, Terrain
- Persistent Multi-Level Secure Networks

Mr. Cameron
Boeing

- M&S is critical for successful DT&E of complex, net-enabled Systems of Systems
  - Requires robust application of M&S across the entire product life cycle
- M&S is available, today, to provide credible DT&E involving Live, Virtual, and Constructive elements
- Partnerships are key – both government/industry, and industry/industry
- Need to effectively deal with impediments
  - Conflicting programmatic/DT&E goals
  - Intellectual Property
  - Security
  - M&S “zealotry”

Mr. Hazlett
Raytheon

- Develop plans to better integrate M&S into design and T&E of future forces
- Create a opportunity to facilitate T&E and M&S exchange and interactions
  – Include specific topics such as Electronic Attack and C^4ISR
- Integrate M&S into development and acquisition programs in a value-added manner
- Integrate M&S into development and acquisition programs in a value-added manner to facilitate integrated development and T&E
- Streamline and update DoD testing security protocol to keep current with changing requirements to protect developmental capabilities
- Think about bringing in the next generation individuals

Common Themes

- Acquisition
  - Sharing/Use of data from M&S to T&E and from T&E to M&S
  - Mapping of M&S Capabilities to T&E Requirements
  - Model – Test – Fix – Model approach
- Definitions
  - Develop a common terminology across M&S and T&E

Common Themes

- Intellectual Property
  - How to share and control data/models?
  - Connectivity concerns?
- Security
  - How to deal with secure networks across government/industry boundaries?
- Partnerships
  - Is there a body required to foster technical interchange of ideas and develop proposals for standards?

Summary of Questions

Question:	What is the difference, if any, between the M&S Master Plan versus the Simulation Support Plan? Isn't the SSP meant to be the "M&S Master Plan" for a program?
Respondent:	Chris DiPetto
Answer:	The Acquisition M&S Master Plan is a broad over-arching plan, developed by representatives of all DoD components. It identifies obstacles which hinder effective and efficient use of M&S in acquisition, and lays out a set of 27 specific actions to address those obstacles. Simulation Support Plans are used by some program offices to document specific plans for using M&S within their particular program. Implementing the actions in the Acquisition M&S Master Plan should facilitate better M&S planning and execution by programs.

Summary of Questions

Question: Is there any plan to establish reportable metrics on how M&S effort saved resources in time, dollars, and system design?

Respondent: George Kai'liwai

Answer: If there aren't plans to use reportable MS metrics, there should be. In developing MS capabilities we assume a certain ROI and generally get agreement from the program offices that they would use these MS capabilities as long as they don't have to pay for them. Whether they use the MS capabilities once we deliver them is a different matter altogether as the TE community cannot force these capabilities on our customers.

Summary of Questions

Question: How can DoD streamline the acquisition process using M&S as an enabler, e.g. what architecture, standards, and tools can/could accomplish this?

Respondent: George Kai'liwai

Answer: We are embarking on an effort to define the Value Stream for our operations. This will help us to stream-line our operations, and improve upon the value we provide to our customers. Another way to potentially streamline the acquisition process is to deploy systems for evaluation, rather than embark on a operational test event. Obtain the operations test information from direct use in a conflict. One way to streamline testing is to deploy prototypes into the field and if possible conduct DT and OT in the field. This would require close coordination with the field commander.

Summary of Questions

Question: What M&S capability will be "left behind" (reuseable) after the April event with Boeing & DMOC? (planning process, network connectivity, models, etc.)

Respondent: George Kai'liwai

Answer: Technical expertise is the primary aspect that we will walk away with. Particularly expertise in distributed testing.

Summary of Questions

Question: Where can a PM go today to find a lit of all the M&S currently in use within DoD, to see what might be of use?

Respondent: Jim Hazlett

Answer: PMs should check with DMSO, and their service's modeling and simulation organizations, such as AMSO and NMSO. This should catch most of the M&S being used in support of acquisition programs and programs of record. As a double check, one should also run the list provided by the service MSO by the system commands (i.e., NAVSEA, NAVAIR, etc.). This should also catch the M&S being used at Warfare Centers. Finally, there is M&S that is being used by DoD that is not necessarily program-related (wargaming models, etc.). To catch this one should check with the war gaming departments at the service colleges, and at the doctrine commands and battle centers. MORS and several other professional organizations do keep some databases on DoD M&S use.

Summary of Questions

Question: Why establish a DoD society and not a National (International?) organization? Probably more potential members outside DoD than within?

Respondent: Jim Hazlett

Answer: Agree that a modeling and simulation society should be more inclusive than just DoD, but it should also be organized to include functionally-focused components (service, DT&E, OT&E, acquisition, open source, gaming, etc.) There is a strong argument to make this a "virtual" organization, due to the nature and diversity of the subject area. A strong web-based effort would probably be the best way to get this going. There could be both national and international branches, where one could matrix themselves in, as appropriate. The national-international linkage should be such that it accounts for export control issues, etc.

Summary of Questions

Question: What can be done (given need for flexibility in DT&E and rigorous VV&A for OT&E and other issues) to facilitate re-use of DT&E assets through the remainder of the program life-cycle?

Respondent: Jim Hazlett

Answer: As spiral development continues to become the more common way of development, acquisition, and testing, the line between D and O T&E, and M&S will blur. We are now facing rapidly evolving threats (i.e., Improvised Explosive Devices (IEDs) and asymmetric warfare) that will require a blend of DT&E, DM&S, and OT&E and OM&S. We will see "build a little, model a little, test a little, field a little (or a lot)...and repeat." FCS and other future programs are likely to evolve steadily over their lifespan, and should be designed to accommodate this reality.

Summary of Questions

Question: There is much DoD talk about distributed environments for systems engineering and test. How can we bring industry into the planning, so in the future industry will be able to propose and use persistent live-virtual-constructive environments in systems development?

Respondent: Steve Cameron

Answer: The very best thing to do would be to ensure industry and government are involved together from the very beginning. We have learned in the past that having the government develop an environment, then tell industry to use it doesn't work well. It is important to treat both industry and government as partners during the requirements stage for such an environment as well as during its actual development. Industry specific issues, such as the protection of Intellectual Property, need to be treated as a concern for all team members (government and industry), and treated up front with the rest of the design requirements. In JMASS, we saw that the government can't do it on its own, and in ACD&D we learned industry can't do it on its own. The answer is "combined (industry/government) development from requirements to deployment."

Summary of Questions

Question: You said that "LabNet enables ad hoc simulation networking." Why "ad hoc" vice "persistent?"

Respondent: Steve Cameron

Answer: I used the term “ad hoc” to mean a particular user can configure LabNet however needed for a particular use. This ability allows us to conduct distributed M&S to virtually any security level. This particular configuration can then remain continuously available (persistent) for as long as the user requires.

Summary of Questions

Question: What motivates a System PO to conduct a Joint distributed event during System Development to find bad news (potentially) with M&S tools that are uncertain and networks that are difficult to establish?

Respondent: Steve Cameron

Answer: This shouldn't become an issue of forcing people to use M&S. Program Managers will use M&S when it helps them best balance/manage cost, schedule, and performance. Instead, we should be focusing on helping a Program Manager determine when and how to use M&S. One glaring hole in this capability, is that we have never really been able to truly show the worth of M&S (in advance of its use…so its use can be weighed from a cost/benefit perspective). Something perhaps easier to do is to create a better decision template for M&S, such as the Acquisition M&S Master Plan is suggesting.

Summary of Questions

Question: In your Virtual WarFare Center, your slide shows it can simulate AEGIS system. How do you validate the AEGIC model (which Lockheed Martin maintains), or are you partnering with them? For example, if it is not a Boeing product, what is the confidence of non-Boeing product simulations in your Virtual Laboratory?

Respondent: Steve Cameron

Answer: This is a Lockheed Martin model used on a program with which Lockheed Martin was a partner, and is used when the agreement for its use applies. In the general sense, industry obtains validation of models to the satisfaction of the customer for that simulation. For systems in our simulations which we do not produce, our company attempts to use models that have been validated by the Customer.

Summary of Questions

Question:	I note you mentioned that an impediment to testing was the inability to achieve statistical significance. Do you really mean this?
Respondent:	Tom Berard
Answer:	Yes. A data point of one is hardly "statistically significant." I'd call that a "demonstration." That does not mean that there isn't a significant amount of information gained from such a demonstration. It's a great learning experience. I also believe that if we have done our job correctly and used M&S to characterize the test event, it can be used to validate the models used.

Summary of Questions

Question: Who funded the multi-service distributed event? Can you speak to the coordination required to make it happen?

Respondent: Tom Berard

Answer: Air Force, Navy, Army paid for their service contributions. JFCOM was not a bill payer for this event.

Session 2
March 7, 2006

- DT&E's Perspectives -
"Making M&S and T&E Better Partners"

Panel Chair: Chris DiPetto

Special Assistant, Systems Engineering

Office of the Under Secretary of Defense
for Acquisition, Technology, and Logistics

- DT&E's Perspectives -
"Making M&S and T&E Better Partners"

Panel:

- **Dr George Ka'iliwai**
  Technical Advisor, USAF Flight Test Center, Edwards AFB
- **Mr Tom Berard**
  Director, USA White Sands Missile Range
- **Mr Steve Cameron**
  Sr Manager, M&S Infrastructure, The Boeing Corporation
- **Mr James A. Hazlett**
  Director, Mission Profiling, Raytheon Corporation

Acquisition Challenges Today

- **Capabilities**
  - Warfighters want <u>better capability, now</u>, versus <u>ideal capability, later</u>
  - Capability-acquisition management versus platform-acquisition management
- **Mission & System Complexity**
  - Broad spectrum of missions; Joint and Network-Centric Operations
  - Many cross-platform interactions and dependencies; IT intensive systems
- **USD(AT&L) imperative:**

"Help drive good systems engineering practices back into the way we do business."

Relevant Acquisition Policy
DoDI 5000.2 May 12, 2003

E5.1 The PM...shall coordinate DT&E, OT&E, LFT&E, family-of-systems interoperability testing, information assurance testing, and M&S activities, into an efficient continuum, closely integrated with requirements definition and systems design and development.

E5.4.7 Appropriate use of accredited models and simulation shall support DT&E, IOT&E, and LFT&E.

Defense Acquisition Guidebook

9.3.4.Modeling and Simulation in DT&E

- **M&S is integral to and inseparable from T&E**
  - Test to confirm system performance & validate M&S
  - Better understanding of interaction of system & environment than with either M&S or testing, alone
- **PM's M&S WIPT develop M&S strategy; T&E manager assist**
  - Plan and start M&S early in program; evolve utility (update) across program's life
  - System M&S used in system test should be the same as, or traceable to, M&S used for concept development, analysis-of-alternatives, system design, and production
  - Synthetic test environments may also be reused for training, operations planning and rehearsal, and subsequent concept developments

Issues facing M&S in Test

- Planning program life cycle strategy for M&S
  - Knowledgeable staff; experienced, skilled help
  - Integrated approach, with industry prime
  - Leveraging reuse opportunities (despite contractor proprietary concerns and self-interest)
  - Contract language, data rights
- Considering and getting needed representations from others
  - Discovering and understanding other representations
  - Access problems of proprietary considerations, misuse concerns
  - Compensation to representation providers
- VV&A
- Security accreditation of distributed environments
- Improving M&S with empirical data, when no one has $
- Maintaining and improving broadly-needed M&S

Resolving the M&S Issues

- 27 actions in draft Acquisition M&S Master Plan
  - Five goals
    - Provide necessary policy and guidance
    - Enhance the technical framework for M&S
    - Improve model and simulation capabilities
    - Improve model and simulation use
    - Shape the workforce
  - Details: see Fred Myers' paper, Thursday March 9, 1PM
  - 1st step; a long way to go
- Acquisition M&S Working Group
  - Voice of the Acquisition M&S community
  - Review and assess execution of Master Plan's 27 actions
  - Identify & submit needs for central funding

Summary
Making M&S and DT&E Better Partners

- Testers need to assist PMs to develop M&S strategies
- M&S must support testing and SE
- M&S is only practical means of SoS capability testing
- Many cross-cutting issues exist that are beyond the reach of PMs & testers; OSD is addressing

Live-Virtual-Constructive Distributed Environments in Support of Test and Evaluation

Major Kelly A. Greene, Ph.D.
Air Force Agency for Modeling and Simulation

NDIA 22nd Annual National Test and Evaluation Conference

Outline

LVC Distributed Environments in Support of T&E

- **Air Force Agency for Modeling and Simulation (AFAMS) Mission**
- **Air Force Modeling and Simulation (M&S) Thrusts**
  - **Accelerated Acquisition**
- **Live-Virtual-Constructive (LVC) Distributed Environments**
  - **Air Force Integrated Collaborative Environment (AF-ICE)**
  - **Joint Mission Environment Test Capability (JMETC)**
- **Test and Evaluation Activities using LVC Distributed Environments**
  - **Multi-Service Distributed Event (MSDE)**
  - **Joint Expeditionary Force Experiment (JEFX)**
- **Joint Test and Evaluation (JT&E) / Joint Feasibility Study (JFS) Activities using LVC Distributed Environments**
  - **Joint Test Environment Methodology (JTEM)**
  - **Joint Command and Control of Net-Enabled Weapons (JC^{2}NEW)**
- **Our Future**
  - **Net-Centricity and Ultimately Net-Enabled Decision-Centricity**
  - **Testing in a Joint Environment**
  - **Key Pieces to Success**

"Advancing Air Force Modeling and Simulation"

Role

Air Force lead for translating policy/direction into effective M&S capabilities integrated across the Air Force and with the rest of the Department of Defense

Chain of Command
- SAF
- SAF/XC
- SAF/XCO
- AFAMS

People
- 74 Total
- 19 Military
- 16 Civilians
- 39 Contractors

Liaisons
- AFRC
- AFRL
- AF/XO
- DMSO
- SOCOM

Laying the Foundation
- M&S Foundations
- Databases/Repositories
- Standards/Coord Tools
- Architectures/Reqs
- AF M&S Strategy

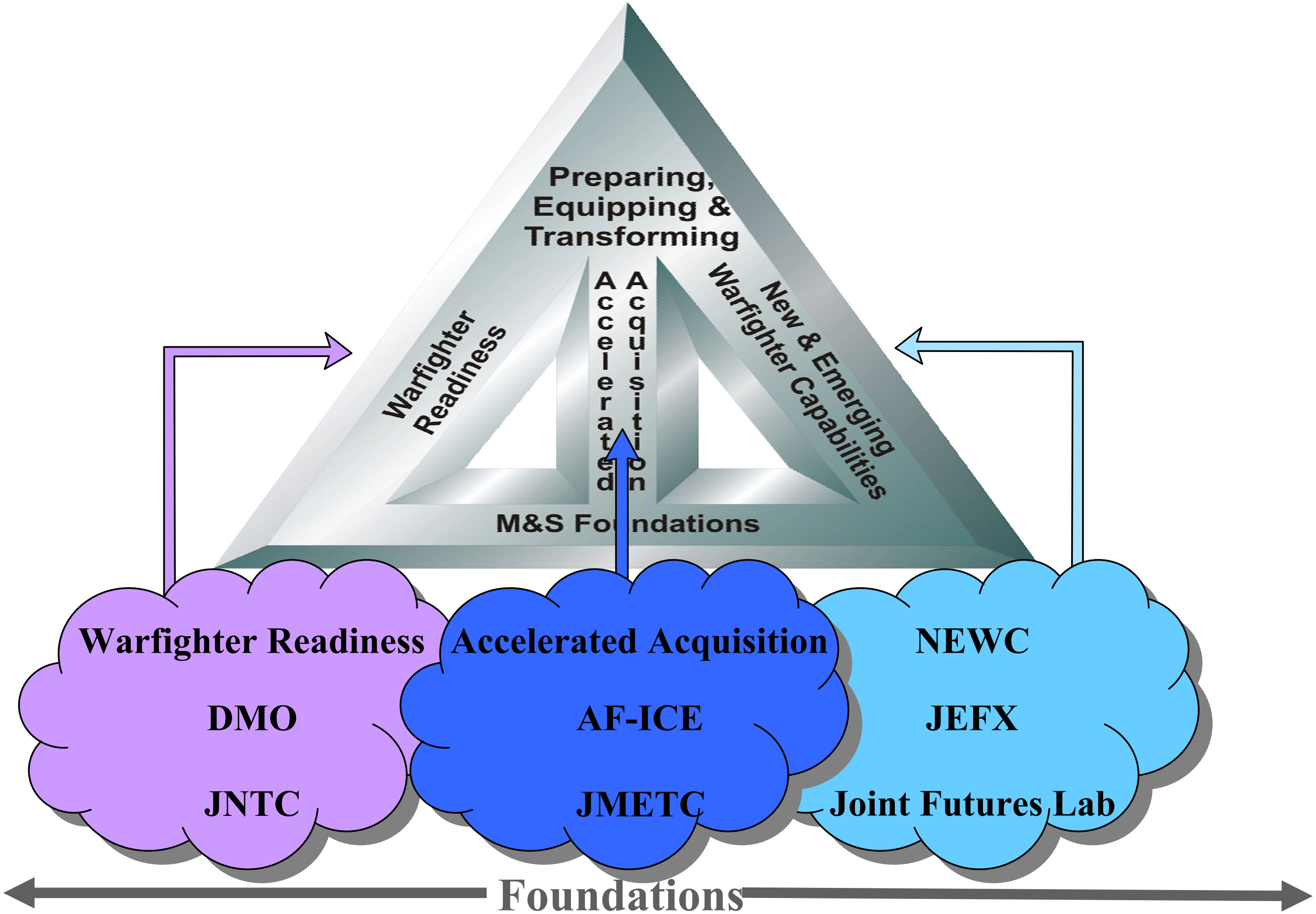
Warfighter Applications
- Trng/Msn Rehearsal/Decision Spt
- A&S Constructive Environment
- Distributed Mission Operations
- Accelerated Acquisition
- Concept Initiatives/Demos
- Experiments/Tech Transition

Building the Community
- Publicizing M&S Story
- Education/Outreach
- Prof Development
- Adv Distr Learning
- Community Forums

Concept Visualization
- Portal into M&S Exercises & Activities
- C4ISR Demos and Trials
- New Technology Demos

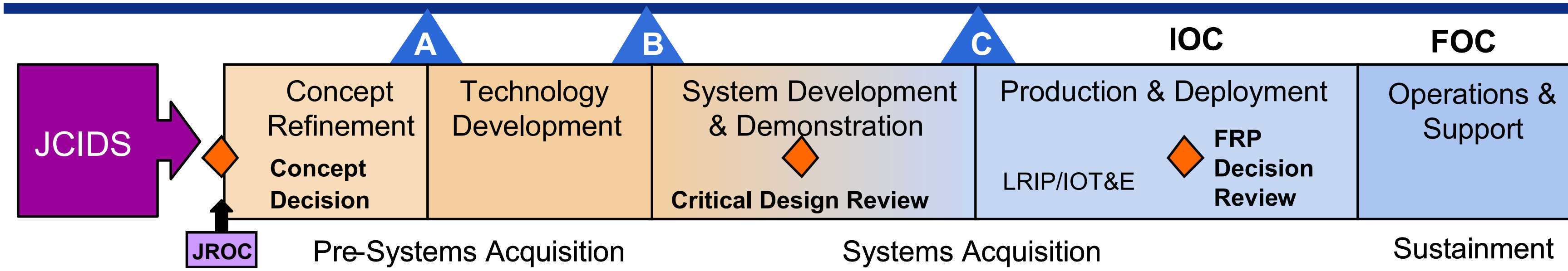
Air Force M&S Thrusts

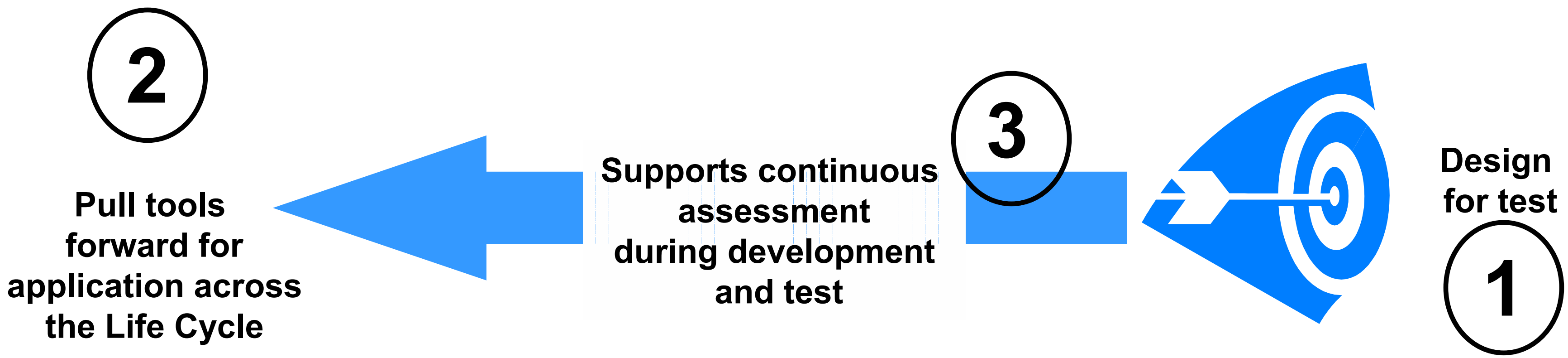
U.S. AIR FORCE




Air Force – Integrated Collaborative Environment (AF-ICE)
New & Emerging Warfighting Capabilities
Accelerated Acquisition
Warfighter Readiness
Analytical Needs
Functional Solution Analysis/ Technology Assessments
Capability Based Planning
Capability Development
Test
Compliance
Sustain
MS&A Collaboration Capability
Technical and Business Operations and Solutions
Acquirers, Testers, Operators, Industry
Standards
Procedures
Templates
Business rules
M&S meta data
Lessons learned
M&S Reuse
Foundations M&S
Technical Reference Model
Legend
Gaps/ Questions
Analytical Needs
Decision Quality Information
Analysis
Constructive (Much faster than real time)
Virtual (People in the Loop)
Live (Links real assests)
PERSISTENT ANALYSIS ENVIRONMENT
Decision-Quality Analytical Information For War-Winning Capabilities
AF-ICE is to Acquisition what DMO is to Training

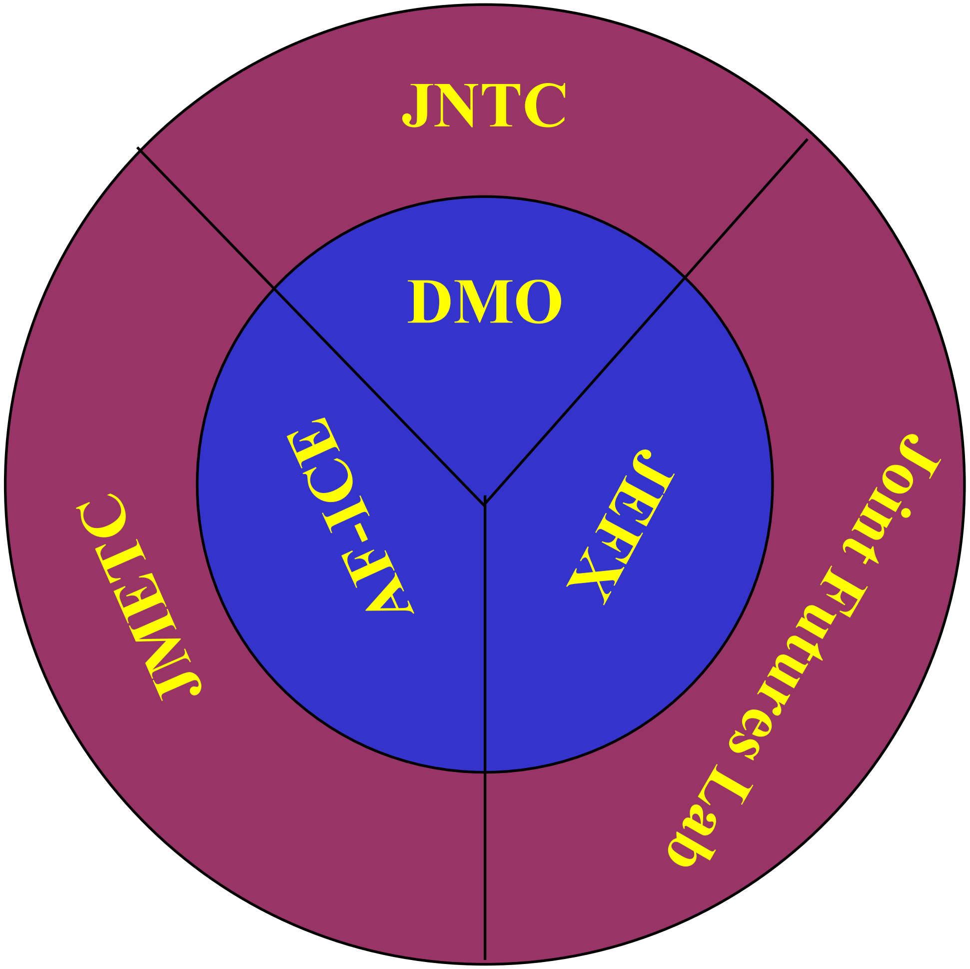
Begin with the End in Mind . . . T&E





Goal – Reuse data across the acquisition timeline… reduces risk and cycle time

Joint Mission Environment Test Capability (JMETC)



Multi-Service Distributed Event (MSDE) Aug 2005

Joint Expeditionary Force Experiment (JEFX)

- JEFX '06: Exploration of Network Centric Operations (NCO)
  - 9 Air Force Initiatives (ConstellationNet, AOC Fusion, Homeland Defense, etc)
  - 5 Army Initiatives (Future Combat Systems)
  - 1 Navy Initiative (Global Hawk Maritime Demonstration)

- Theater Battle Management Core Systems (TBMCS) Version 1.1.4 Development Test
  - Theater Battle Operations Net-centric Environment (TBONE)
  - Spirals Nov 05, Jan 06, Mar 06
  - Execution Apr-May 2006

- JEFX '08 Theme to Focus on Joint Command and Control

Joint Test Environment Methodology (JTEM)

U.S. AIR FORCE

7 Steps
11 Processes

STEP 0

JCIDS Document

- Joint Mission Definition

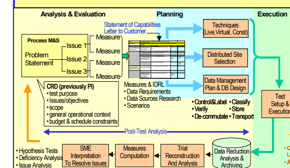
STEP 1

- System Specific Joint Mission Scenario

STEP 2

- Develop Joint Test Scenario
- Perform JME Concept Analysis

STEP 3



- Create Analysis Plan

Individual System Scenario

Joint Mission Definition

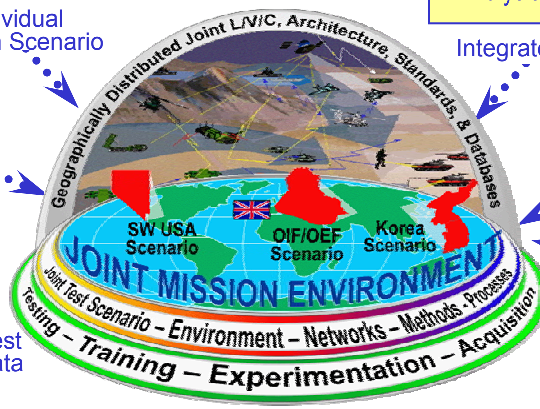
Integrated Scenario

Data Collection

Scenario Design

Test Data

Distributed L/V/C Design

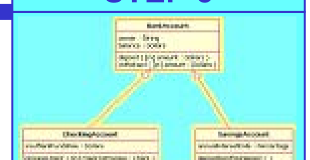


Validated by Methods and Processes Working Group on 30 Nov 05

STEP 4

- Develop Detailed Test Scenario
- Allocate Functionality
- Analyze JME Concept & Define Detailed JME Description

STEP 5



- Define JME Object Model

Execute Test Event

STEP 6

- Conduct Joint Mission Effectiveness Analysis

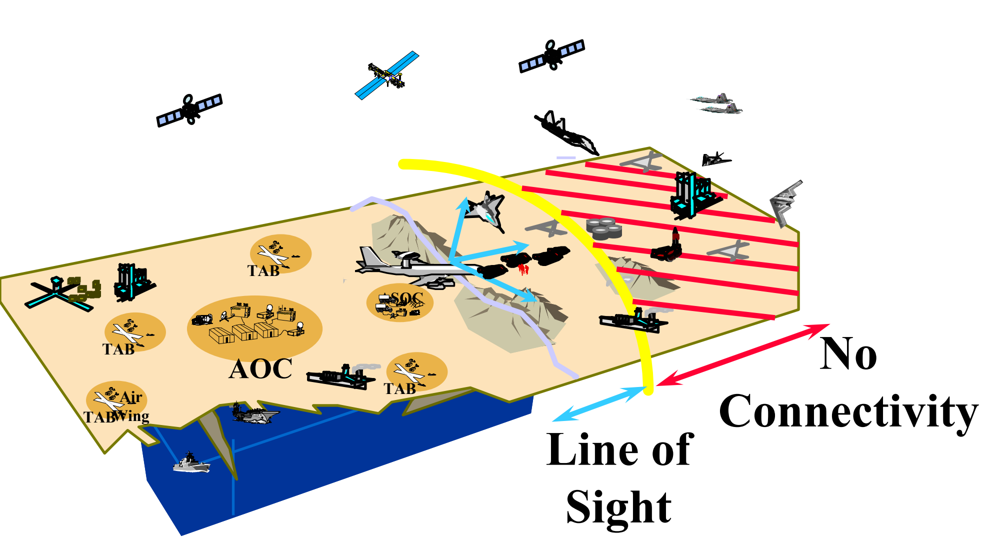
Joint Command and Control of Net-Enabled Weapons (JC²NEW)

- Weapon In-flight Tracking
  - Strike De-confliction and Synchronization
  - Health, Arming Status, Location, Target Acquisition, …
- Weapon In-flight Target Update
  - Key For Moving and Mobile Targets
  - Key Enabler for Interdiction Role
- Weapon Retargeting
  - Importance Increases with Standoff
  - Enhanced Time-Sensitive-Target Capability
- Weapon Impact Assessment (WIA)
  - Post-strike Assessment and Re-strike Decisions
- Weapon Abort

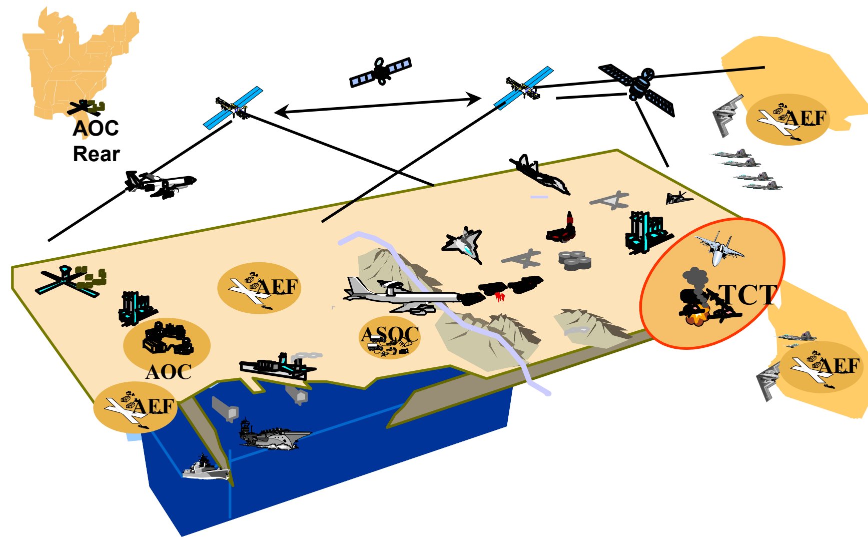
Net-enabled weapons complete the "Kill-Chain" – from desired actions to direct effects on the battlefield, while providing the conduit for near-real-time feedback to decision makers

U.S. AIR FORCE

Net-Centricity



STOVE-PIPES



NO WARRIOR FIGHTS ALONE!

Platform-Centric Operations

- Limited Situational Awareness
- Limited Real Time Control
- Limited En Route Planning

Net-Centric Operations

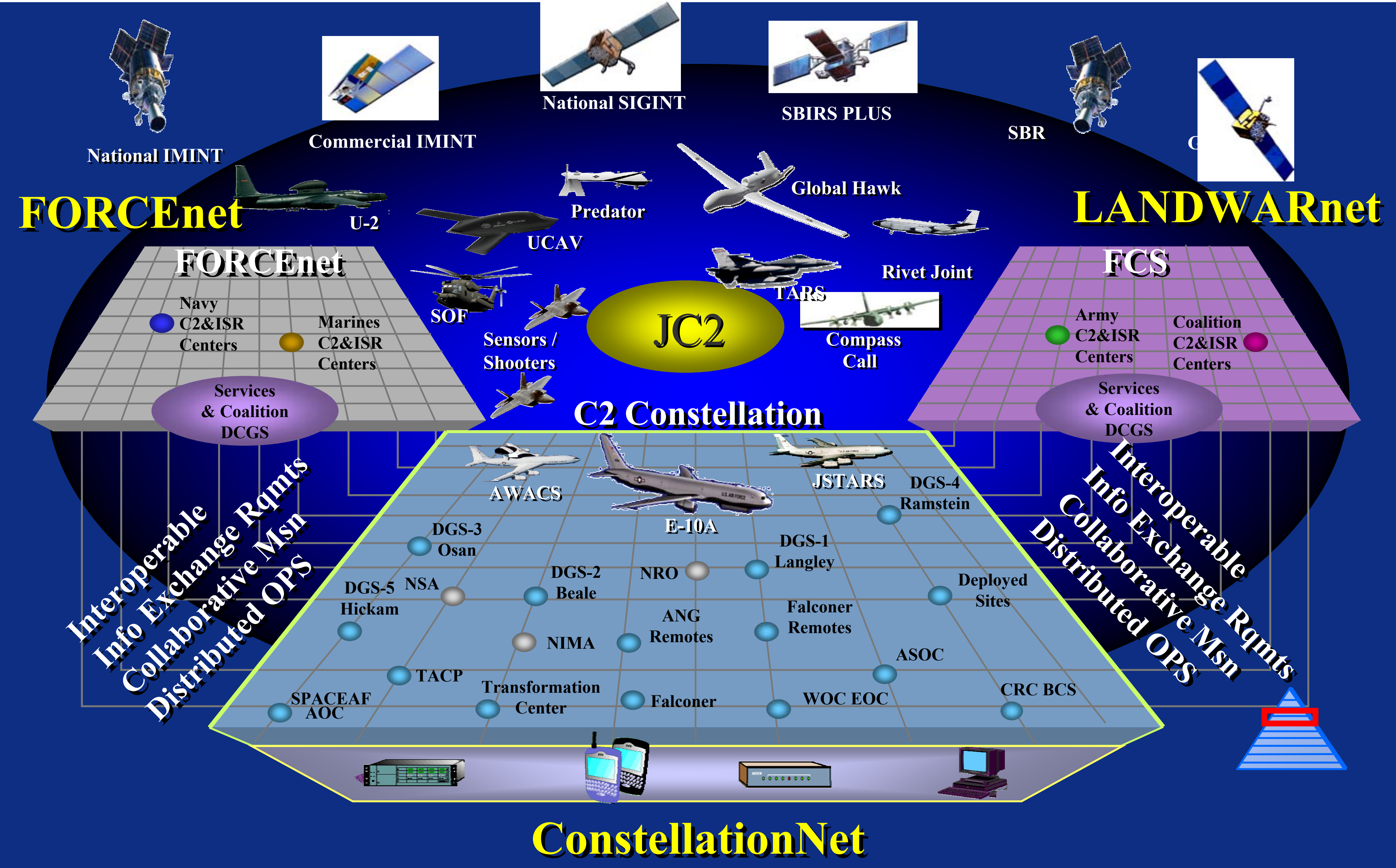
Distributed Forces
Family of Integrated Operational Pictures
Real Time Situational Awareness
Precision Engagement
En Route Planning & Targeting

The Ultimate End State is Decision-Centric Operations Employing a Network-Centric Infrastructure "NETWORK-ENABLED WARFARE"

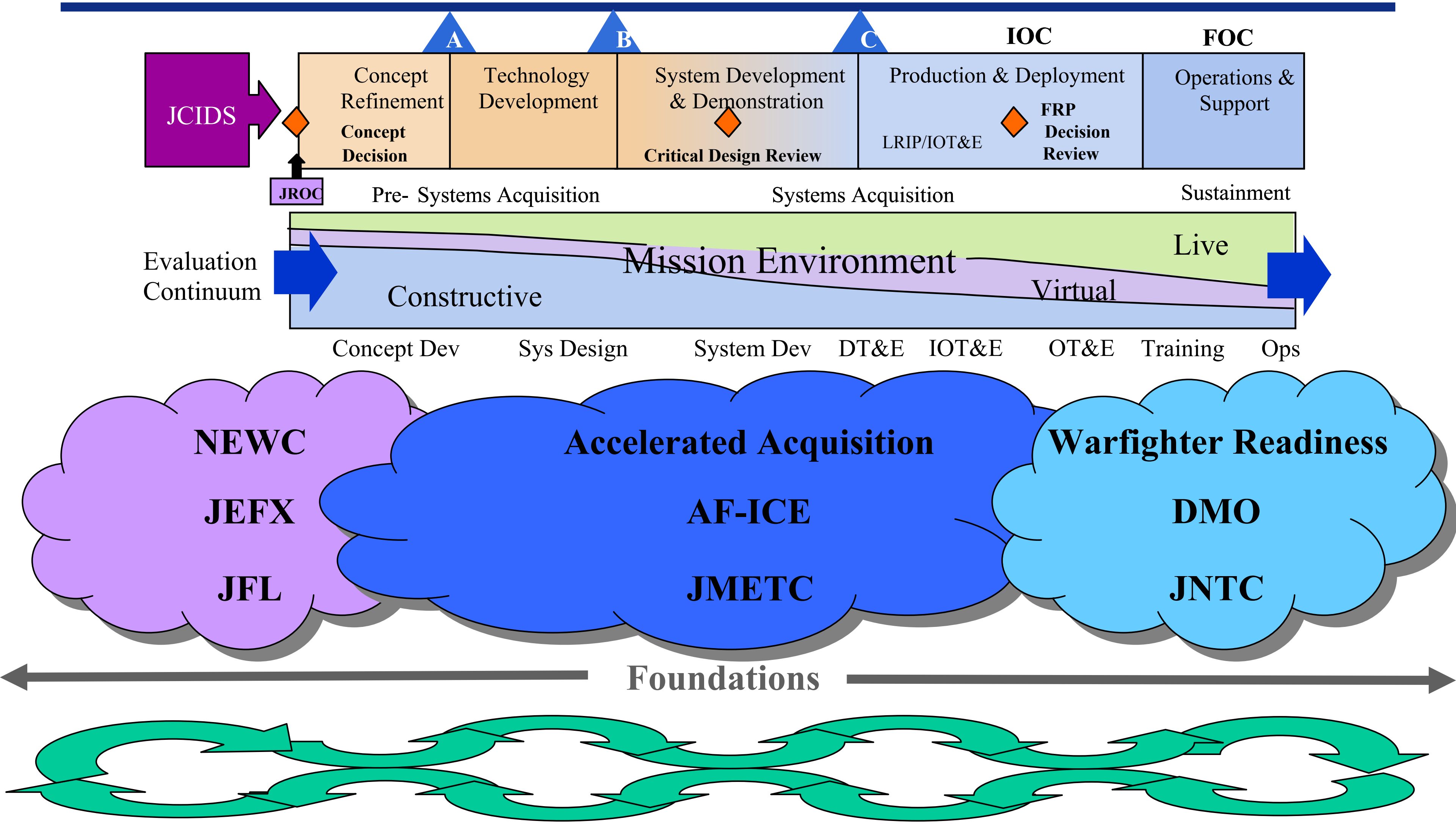
U.S. AIR FORCE

Decision-Centricity

Joint Integration through the Global Information Grid



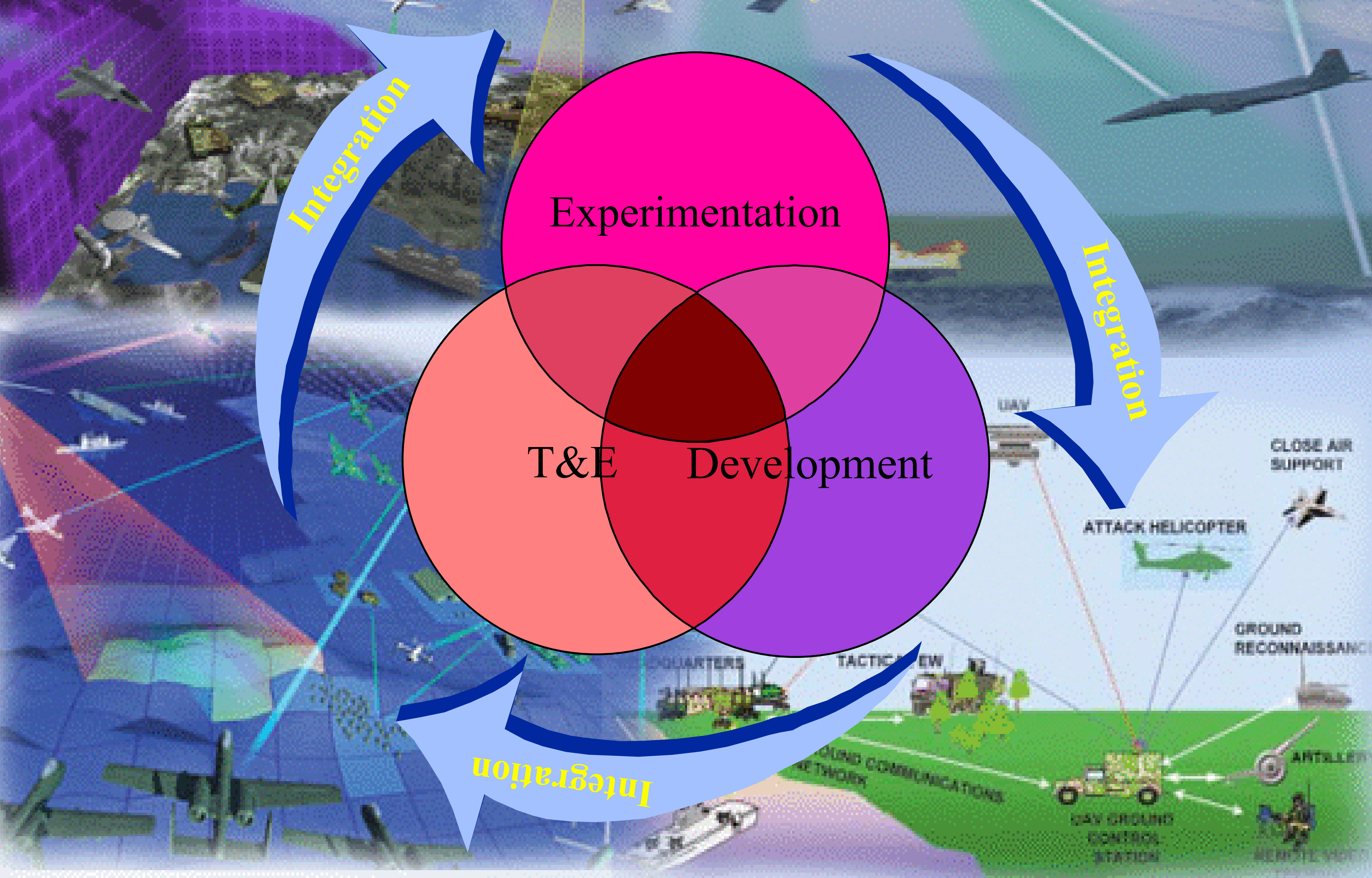
Testing in a Joint Environment

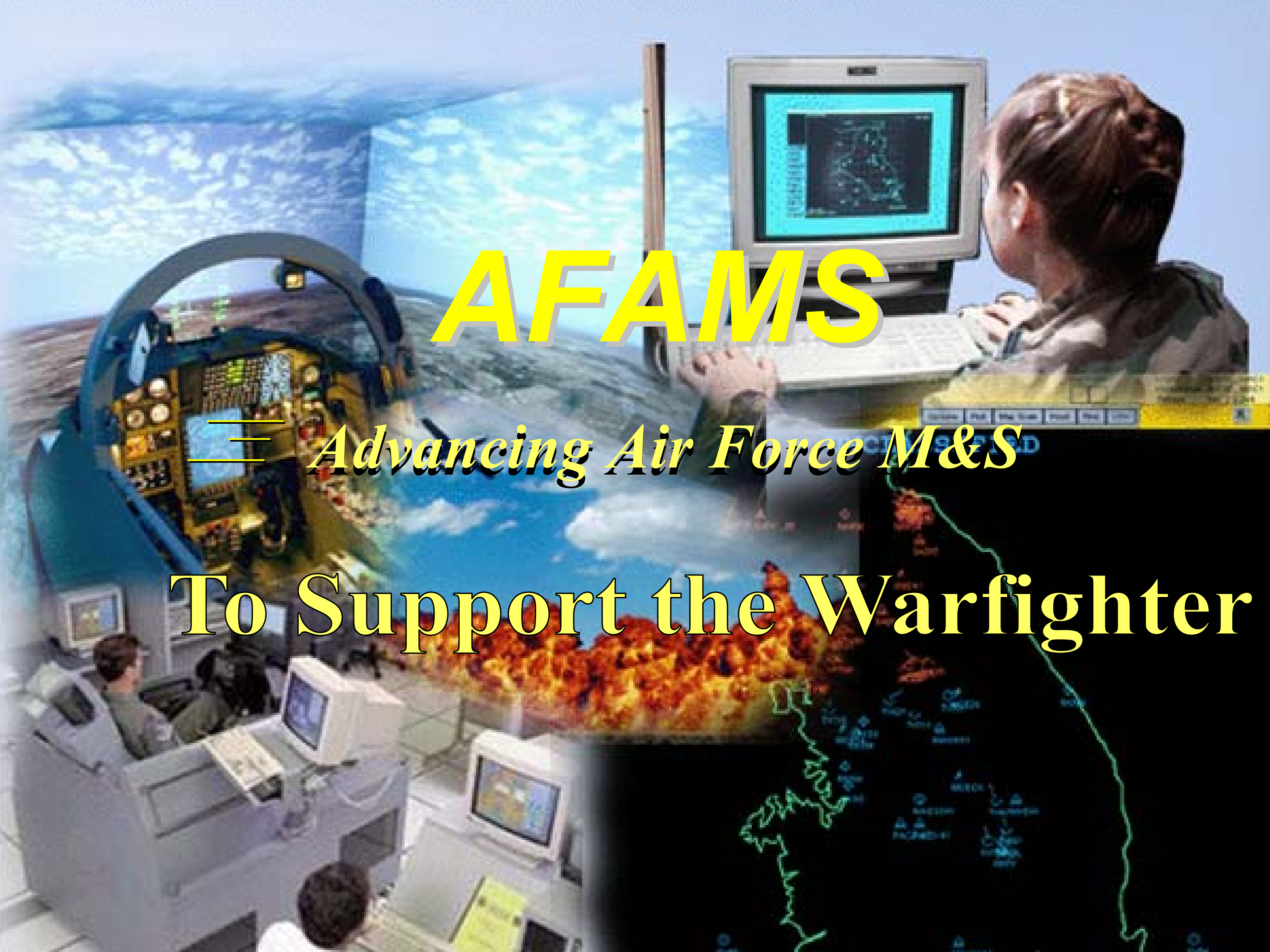


Integrity - Service - Excellence


Key Pieces to Success
Experimentation
Development
T&E
Integration

Key Pieces to Success
An Iterative Cycle




AFAMS
Advancing Air Force M&S
To Support the Warfighter

Raytheon
Customer Success Is Our Mission

T&E M&S War Game Results

Jim Hazlett
Director, Mission Profiling
Mission Innovation
Raytheon Integrated Defense Systems

Game Overview

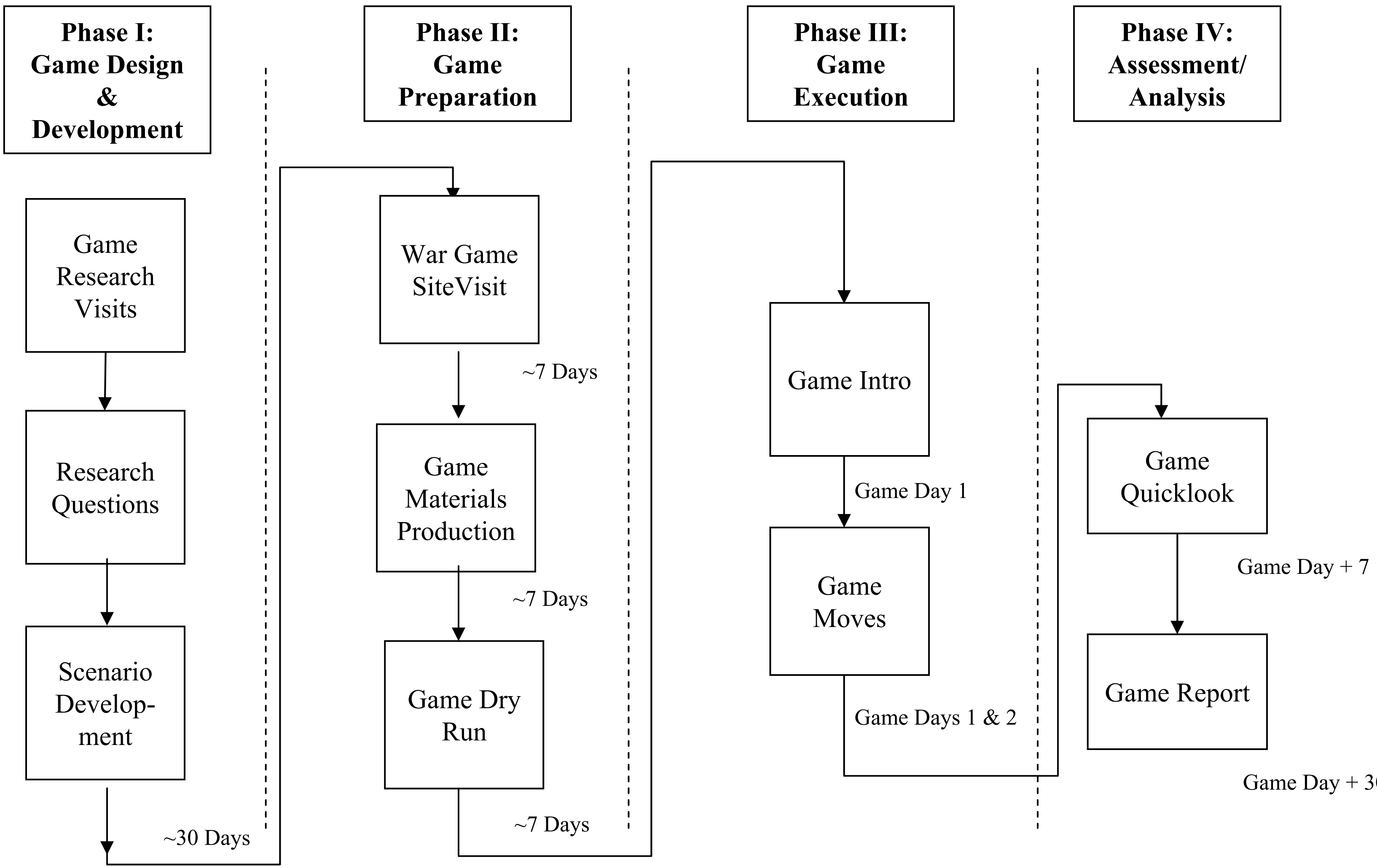
- Purpose:
  - Recent seminar war game for modeling and simulation (M&S) sponsor to identify areas for M&S strategic investments in support of future force developmental and operational test and evaluation (T&E)
- Participation:
  - About 30 players from T&E, M&S, developmental & operational test & evaluation (DT&E /OT&E) and other communities
  - Divided into three interdisciplinary teams
  - Game research, design, facilitation and reporting provided to players
- Game Research:
  - Purpose:
    - Understand the challenges
    - Gather appropriate issues for game discussion
    - Build credible scenarios
    - Identify subject matter experts
  - Generate interest in game
  - About 15 DoD, joint and service commands and organizations visited

Game Scenarios and Moves

- Scenarios (2015 – 2020):
  - Provide participants with a context for discussion – not an operational war game
  - Three representative scenarios (linked to Defense Planning Guidance (DPG) scenarios)*:
    - Urban canyon
    - Triple canopy jungle
    - Rugged terrain
- Four moves (Given a Future Blue Force):
  - Move 1: Red Move – Counter the Blue Force
  - Move 2: Blue Force Evaluation Metrics
  - Move 3: Test the Blue Force – Identify needed T&E capabilities and specific M&S challenges
  - Move 0: Characterize the barriers between present and future state and capture T&E, M&S strategic priorities

* All with Deep Underground (DUG) facilities

Game Approach



Game Move Design

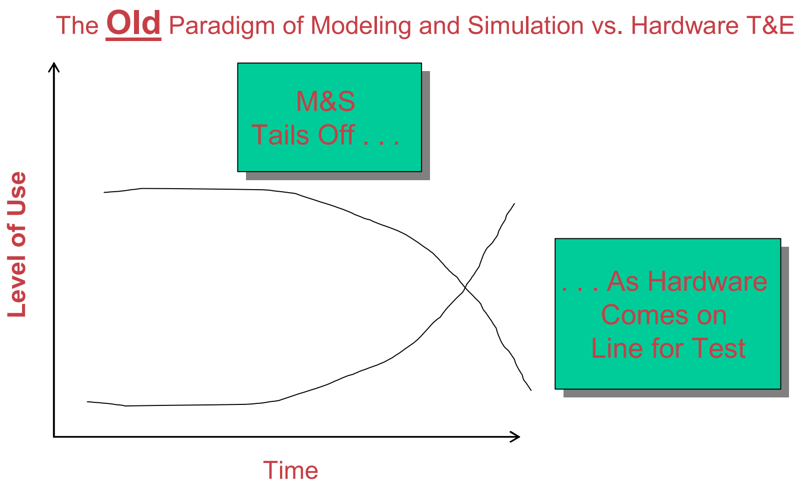
	Move 1	Move 2	Move 3	Move 0
Scenario A	Team A: Red-team Blue force	Team A: Develop Blue force metrics	Team A: ID T&E caps and M&S challenges	Team A: Strategic priorities
Scenario B	Team B: Red-team Blue force	Team B: Develop Blue force metrics	Team B: ID T&E caps and M&S challenges	Team B: Strategic priorities
Scenario C	Team C: Red-team Blue force	Team C: Develop Blue force metrics	Team C: ID T&E caps and M&S challenges	Team C: Strategic priorities

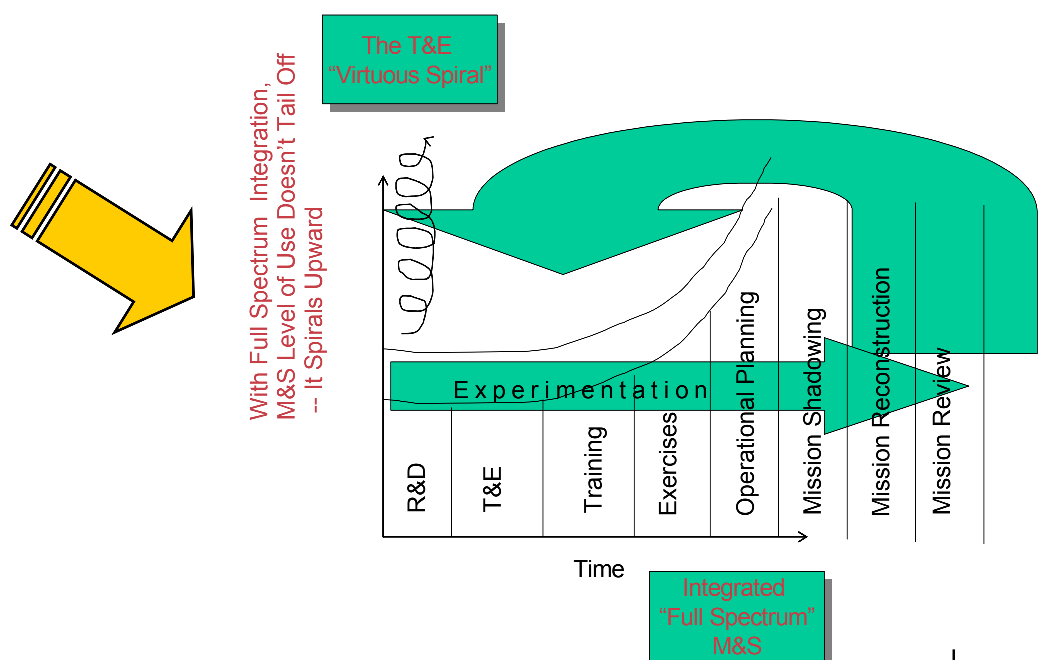
Tactical

Strategic

Competing T&E M&S Paradigms

- The current/“old” paradigm of reduced modeling and simulation as hardware comes on line will no longer apply as M&S matures and as T&E integrates with other systemic M&S





Recommended Actions (1)

- Develop a mapping of M&S capabilities into T&E requirements
- Develop plans to better integrate M&S into design and T&E of future forces
- Create a DoD T&E and M&S professional society to facilitate T&E and M&S exchange and interactions and to foster development of next generation of T&E and M&S professionals
- Integrate M&S into development and acquisition programs in a value-added manner
- Organize Electronic Attack (EA) T&E/M&S workshops to address how EA and other network disruptions are addressed in programs, T&E and M&S
- Examine how T&E and M&S is being employed by specific programs to address C^4ISR backbone issues
- Define situational awareness/understanding and sensor fusion representation requirements for developmental and acquisition programs and for T&E and M&S communities

Raytheon
Integrated Defense Systems

Recommended Actions (2)

- Work with National Geospatial-Intelligence Agency (NGA) to develop common set of terrain requirements and representations to support programs and T&E
- Promote improved collaboration between T&E and M&S community and joint/service Red, intel, and doctrine development (including joint).
- Integrate M&S into development and acquisition programs in a value-added manner to facilitate integrated development and T&E
- Invest in M&S representation of sensor fusion to support system development and T&E
- Examine use of M&S in development of future force with an eye toward integrating it in such a way that it optimally supports system development and T&E (i.e., Improvised Explosive Devices (IEDs)
- Institute DoD M&S/T&E professional organization to support information exchange, coordination, and community replenishment and growth
- Streamline and update DoD testing security protocol to keep current with changing requirements to protect developmental capabilities
- Work with T&E and community to collaborate on various visions, paradigms and versions of future programs

Major Strategic Findings

- Make investments:
  - M&S of system of systems and representation of C^4ISR fusion
  - Developing joint M&S collaborative environment, infrastructure and common framework
  - Scalable/high-fidelity, composable, transformable architecture;
  - Robust synthetic natural environment
    - i.e., wave propagation and terrain modeling
- Develop capabilities
  - Provide replication of:
    - Equipment and systems
    - Trained personnel
    - Territory
  - Capture secondary, systemic effects of equipment and system changes
  - Experiment with new doctrine and developmental capabilities – e.g., asymmetric warfare

Test and Training Enabling Architecture (TENA) Offers Range Interoperability and Resource Reuse Solutions for Test and Training Ranges

Gene Hudgins

TENA User Support Lead

NDIA Test & Evaluation Conference, Jacksonville, FL

TENA Mission

Currently, range systems tend to be non-interoperable, "stove-pipe" systems

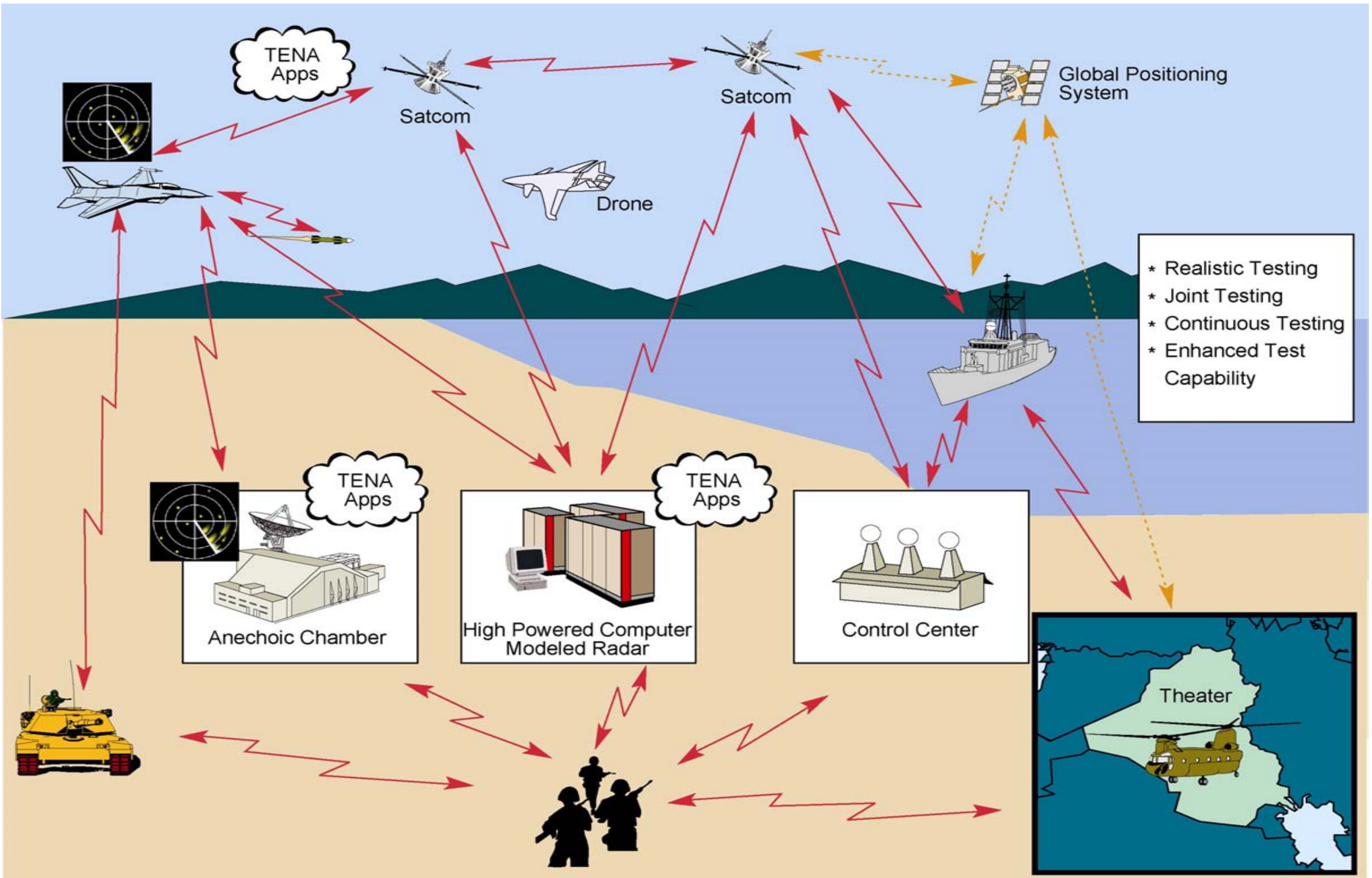
The purpose of TENA is to provide the architecture and the software implementation necessary to

- **Enable Interoperability among Range systems, Facilities, Simulations, C4ISR systems in a quick, cost-efficient manner, and**
- **Foster Reuse for Range asset utilization and for future developments**

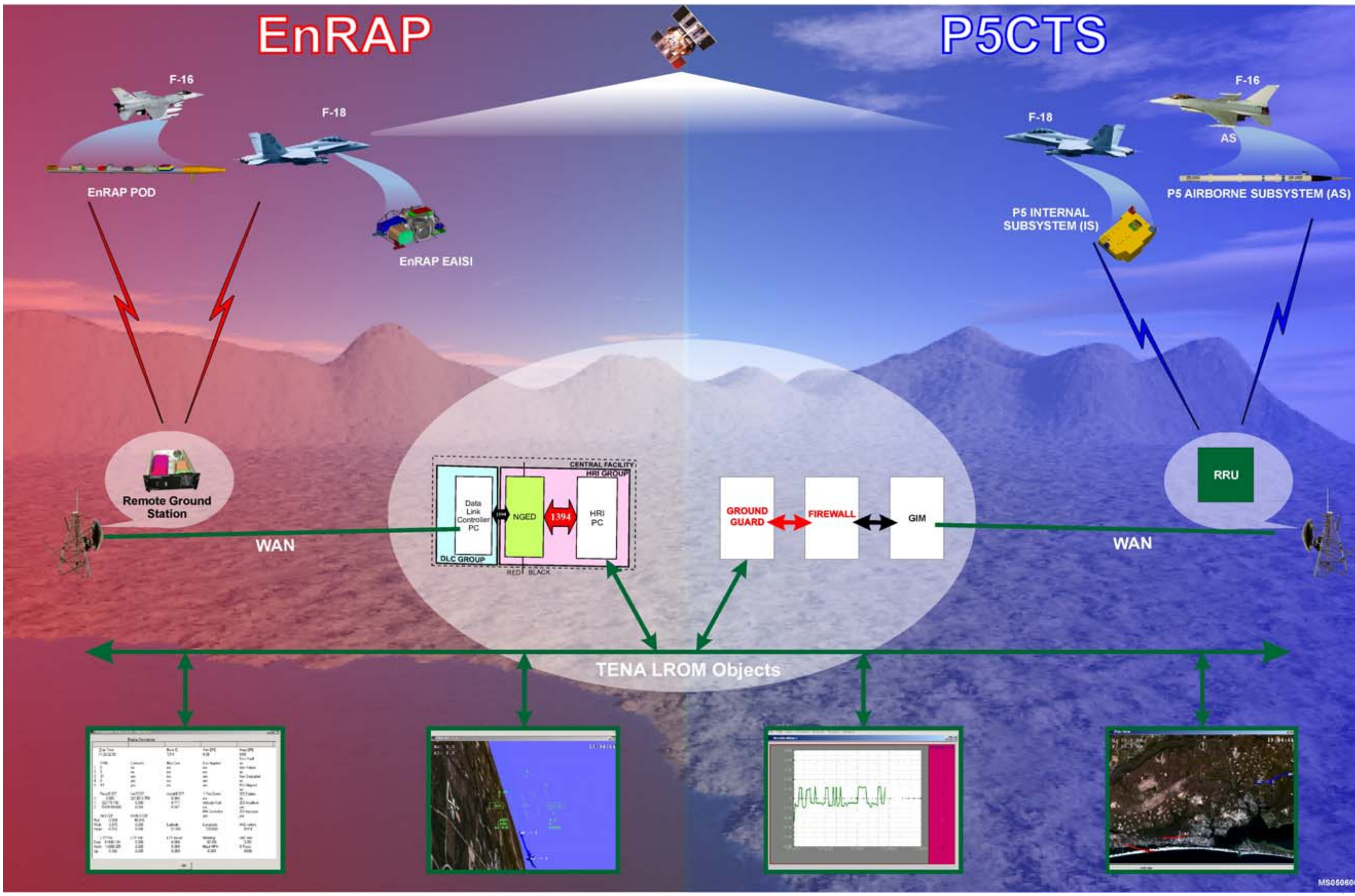
> - **Support the Warfighter (Joint Vision 2010/2020)**
> - **Enable Simulation-Based Acquisition**
> - **Foster Test and Training Integration**
> - **In the long term: SAVE MONEY!**

Lay the Foundation for Future Test and Training Range Instrumentation

CTEIP Integrated Architecture Global Command and Control Network



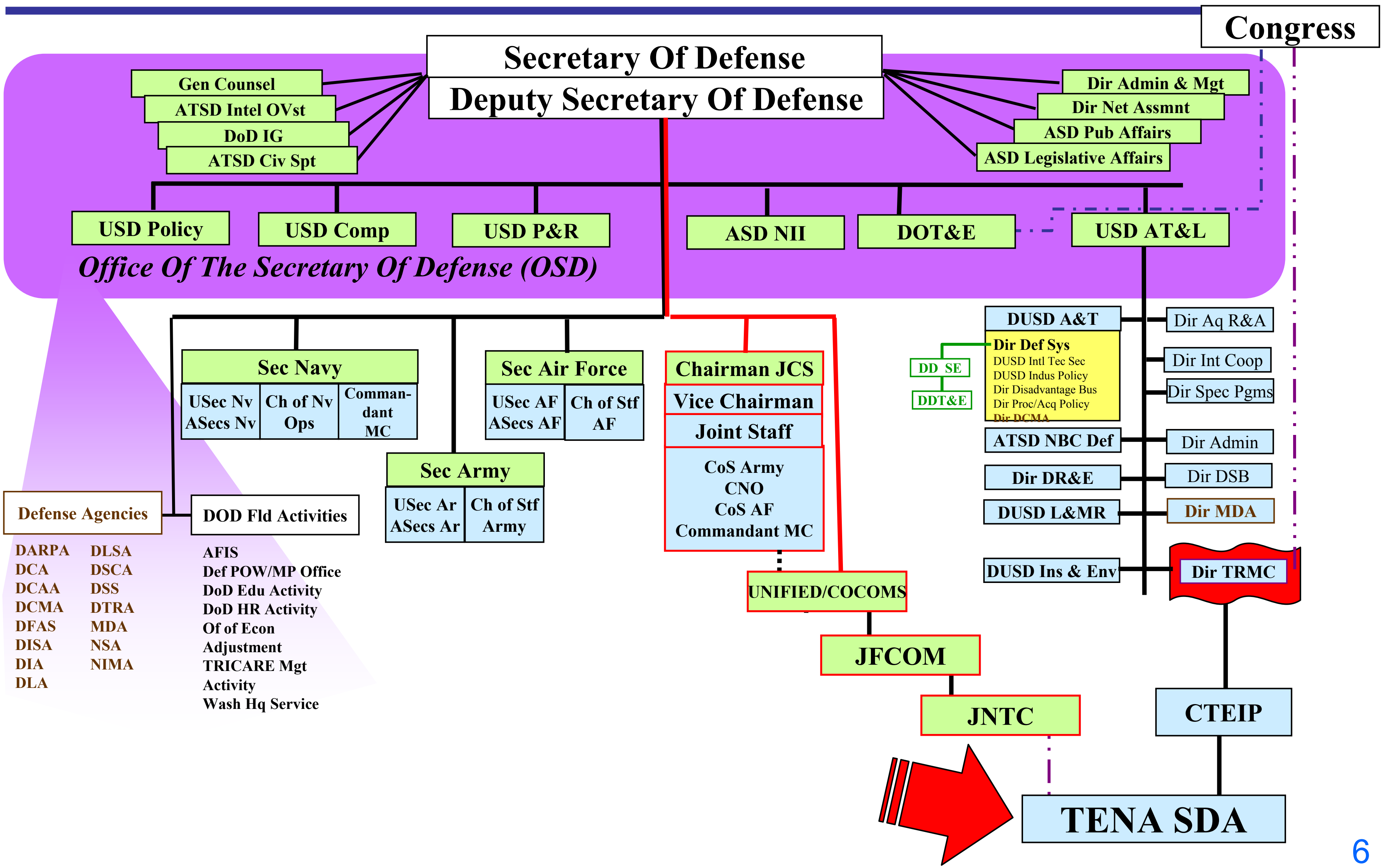
TENA is a Test and Training Interoperability Enabling Technology



TENA Software Development Activity (TENA SDA)

- TENA Software Development Activity (TENA SDA) will assume sustainment and future development responsibilities for TENA for both the test and training communities
- Reports to CTEIP and the JNTC Joint Management Office (JNTC JMO) on all TENA-related activities, including but not limited to:
  - Sustainment of TENA Middleware
  - Ports to different operating systems
  - Upgrades to the TENA Middleware
  - Upgrades to TENA-related tools and utilities (such as the auto-code generator)
  - Distribution of TENA Middleware
  - Distribution of source code generated from object models
  - Correction of software defects
  - Technical support to TENA users, including on-line help desk and TENA Training
- Upgrades to TENA capabilities will stem from:
  - Inputs from the Services (including from the annual reports the Services provide on their implementation of TENA on their systems)
  - Inputs from the T&E Executive Agent Needs and Solutions process
  - Joint training requirements through the JNTC JMO
  - Common requirements identified by members of the TENA AMT
  - Feedback provided by TENA users
  - Results/observations from test and training events
- Other responsibilities include chairing the TENA AMT

Where TENA SDA Fits in DoD



TENA Software Development Activity (SDA) Objectives

- **Refine and sustain the common Architecture for the test/training range community – "TENA" (Test & Training Enabling Architecture)**
  - Define a common **Object Model** to be used across the ranges
  - Continue development of a common Software **Middleware** that:
    - Uses the object model
    - Enhances interoperability and reuse among the ranges
- **Refine common understanding of range processes – the Logical Range Concept of Operations**
- **Define and prototype common Tools to configure and conduct multi-range, synthetic test events or training exercises**
  - Create distributed, synthetic battlespaces with real weapon systems
  - Link multiple ranges together to form a larger, cohesive range
  - Enable testing, assessment, experimentation, and training of weapon system interoperability, C4ISR, and system-of-systems

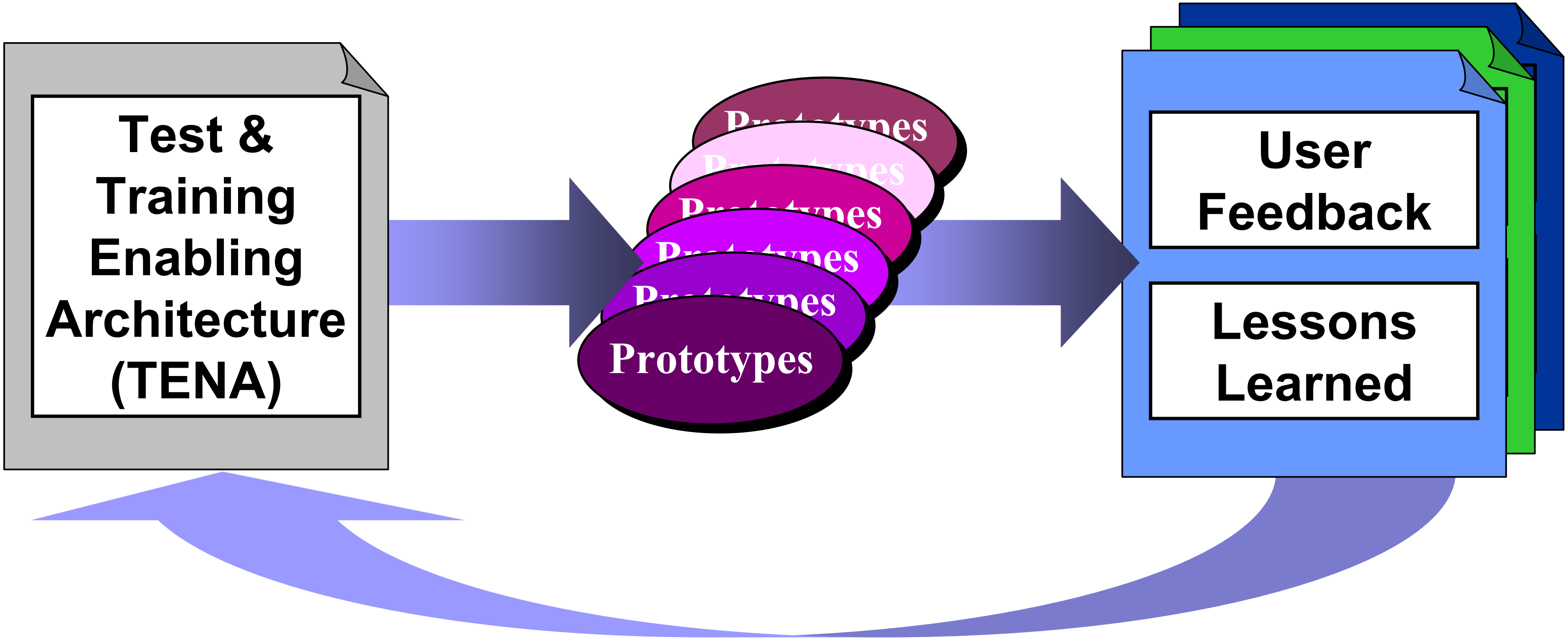
Architecture Management Team (TENA AMT)

- System Engineers & Technical Leads for the current major stakeholders of TENA
  - AAC, Eglin AFB FL
  - NUWC, Newport RI
  - RTTC, Huntsville AL
  - PMRF Synthetic Range
  - EPG, Fort Huachuca AZ
  - WSMR, White Sands NM
  - NAWC-AD, Pax River MD
  - P5 Combat Training System
  - Virtual Proving Ground (VPG)
  - Joint National Training Capability (JNTC)
  - NAWC-WD, China Lake & Point Mugu CA
  - Next Generation Range Instrumentation (NexRI)
  - New Generation Targetry System (NGATS)
  - Enhanced Range Application Program (EnRAP)
  - NAVSEA Warfare Center – Keyport, Keyport, WA
  - Common Training Instrumentation Architecture (CTIA)
  - Army Operational Test Command (OTC), Fort Hood, TX
  - NAVAIR Tactical Training Ranges Program Office (PMA-205)
- Design Decisions / Trade-offs / Status
- TENA Use Cases / Prototype Test Strategies
- Technical Exchanges of Lessons Learned
- Issues & Concerns Identification, Investigation, & Resolution

Meetings every 6-8 weeks

Raytheon, Boeing, SAIC, APL, MIT LL, JITC, DMSO, NRL, VMASC & ATC also attend & participate

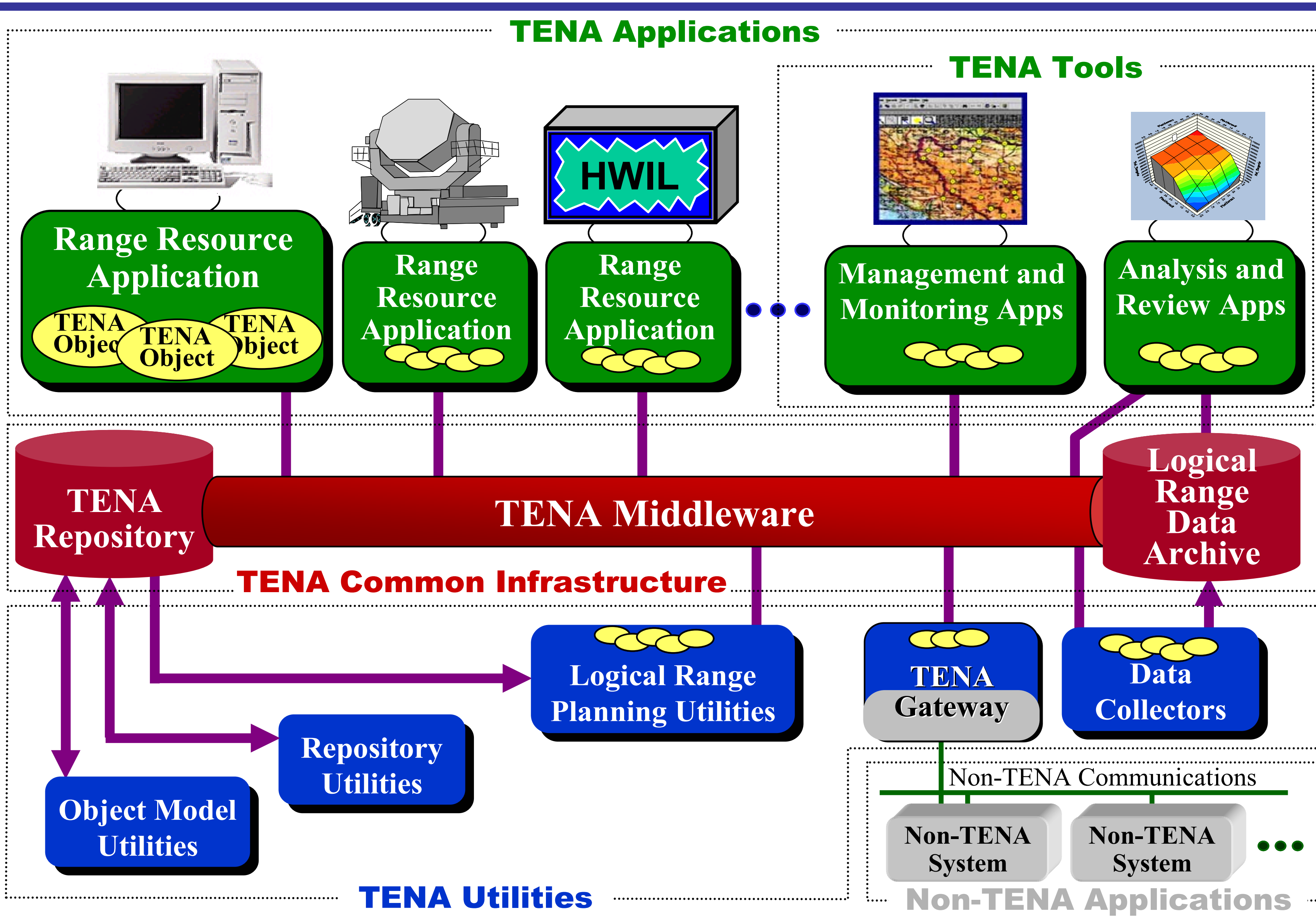
TENA Was Developed in Spirals with the Ranges Involved



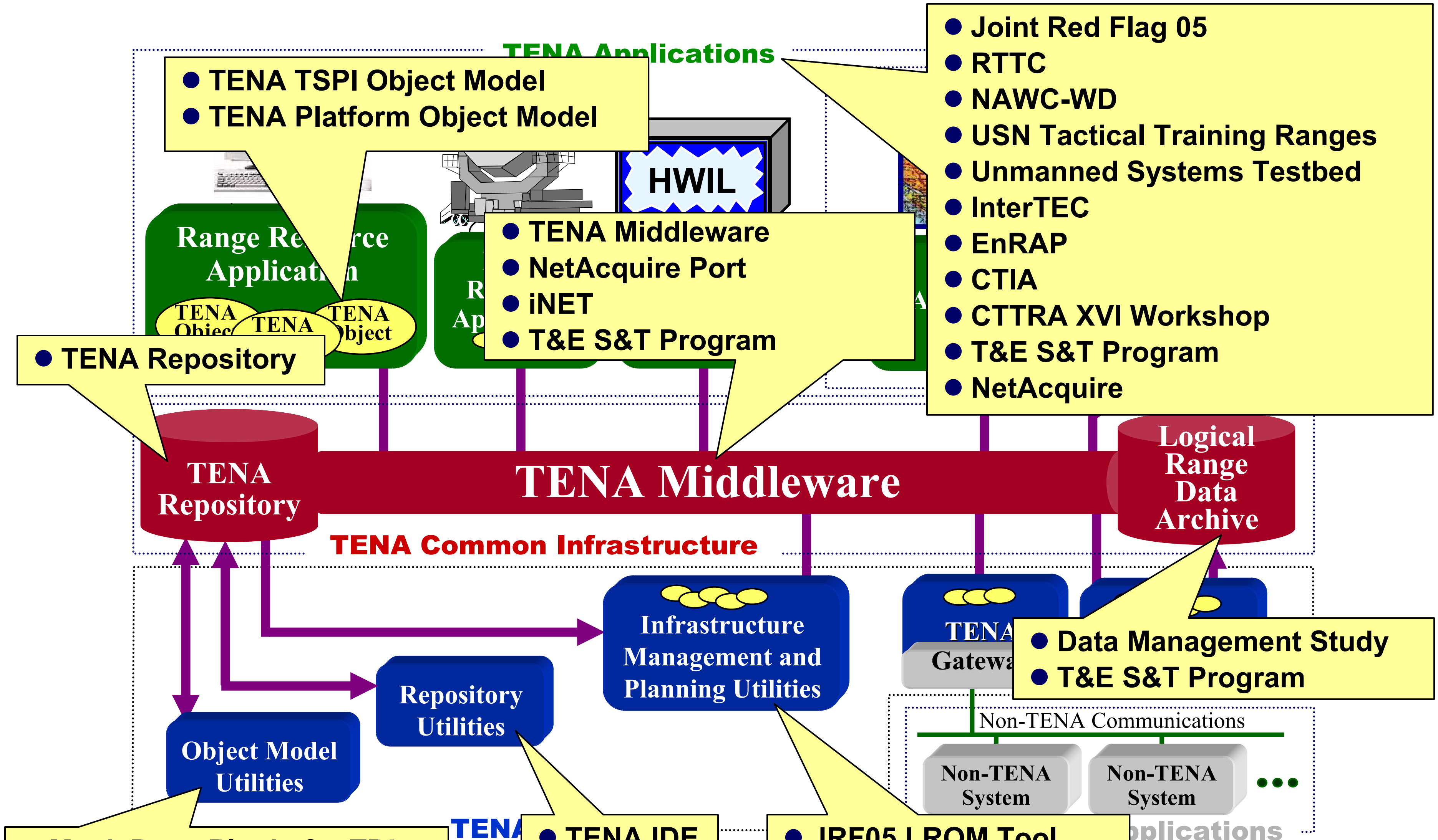
- TENA was revised based on user feedback and lessons learned from working software prototypes
- TENA will continue to evolve based upon emerging requirements
- TENA users (via AMT) determine what functionality is added to TENA

TENA is based on real-world tests at real ranges

TENA Architecture Overview



TENA Architecture Overview with Current Efforts Highlighted



Ways TENA Middleware Can Exchange Data

- **TENA presents to the range user a unification of several powerful inter-application communication paradigms**
  - **Publish/Subscribe**
    - **Similar in effect to HLA, DIS, or other PDU-based communication systems**
    - **Each application publishes certain types of information (the publication state) which can be subscribed to by any other application**
  - **Remote Method Invocation**
    - **Similar to CORBA or Java RMI**
    - **Each object that is published may have methods that can be remotely invoked by other applications**
  - **Messages**
    - **Individual messages that can be sent from one application to one or more other applications**
  - **Data Streams**
    - **Native support for audio, video, telemetry, and tactical data links**

Data Streams Demonstrated at Recent AMT Meeting

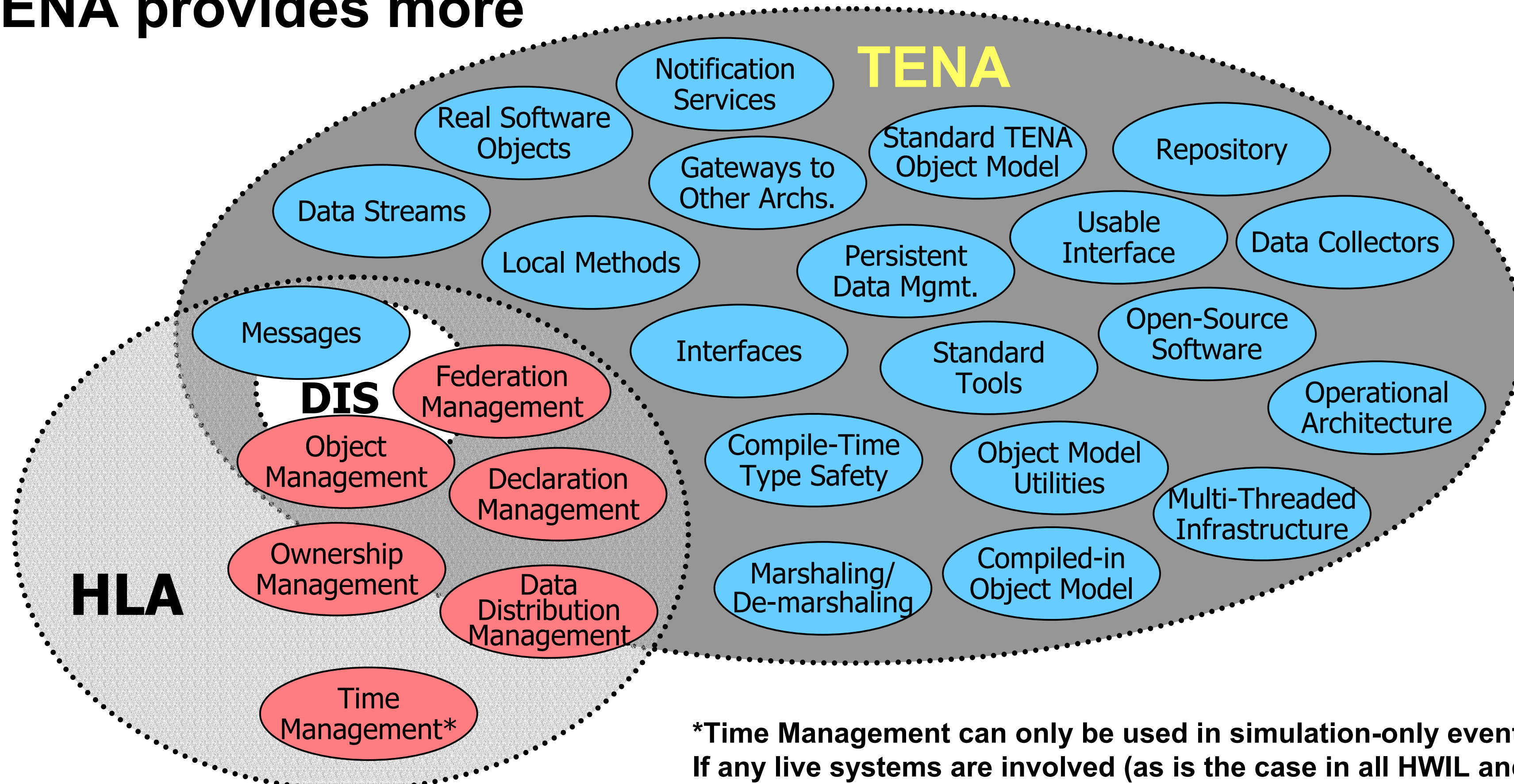
- **TENA provides remote control of data streams**
  - **Allows COTS/GOTS (such as, third-party vendor) streaming solutions and technologies to be used**
  - **TENA approach promotes interoperability and reuse by standardizing software interfaces and supporting the packaging of server/client stream components**

Live Video Stream Transmitted over Wireless Network

Video Stream File Played Back over Wireless Network

Capabilities of DIS, HLA, and TENA

- DIS only provides network, "on-the-wire" standard
- HLA provides some services and capabilities
- TENA provides more

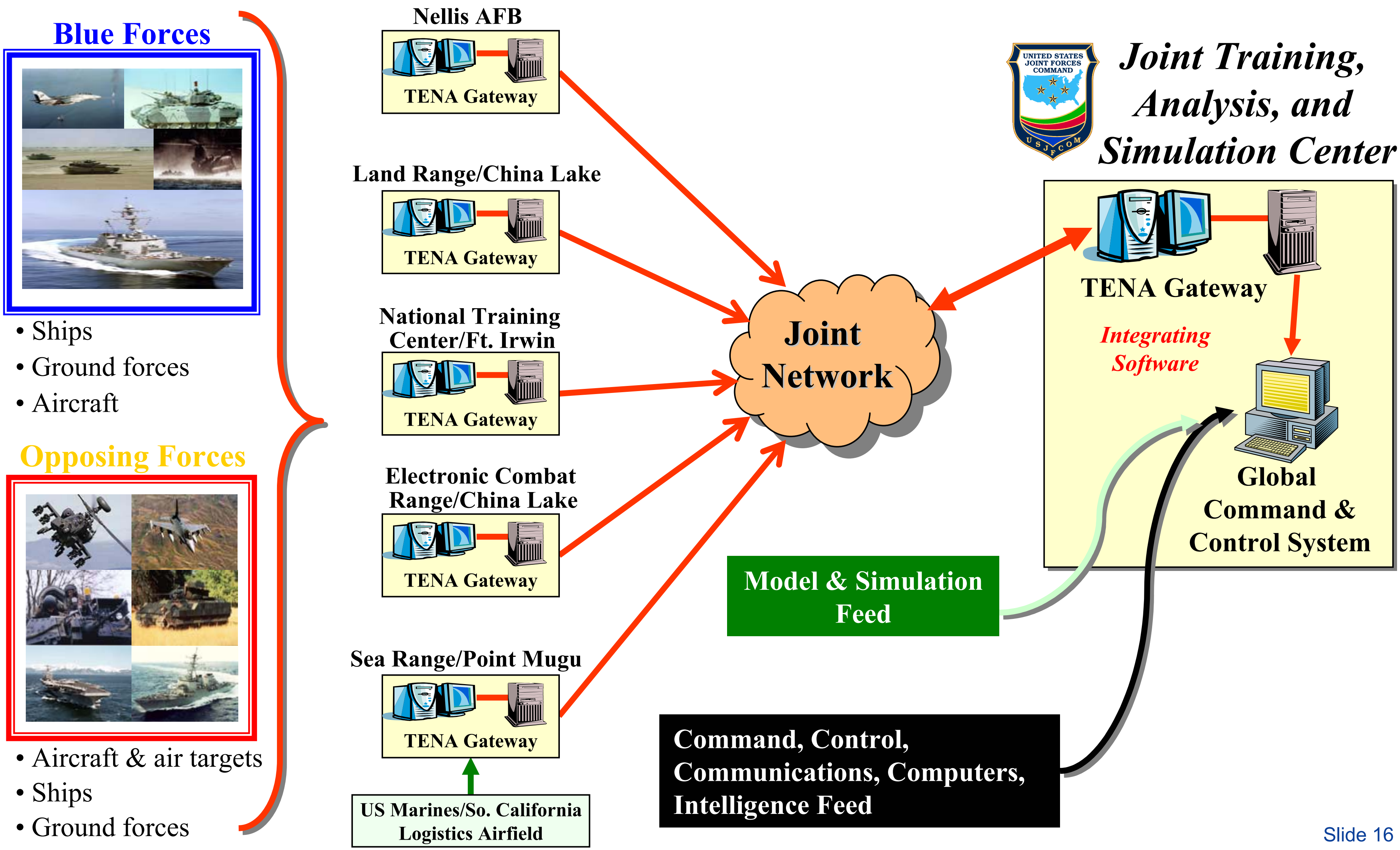


*Time Management can only be used in simulation-only events. If any live systems are involved (as is the case in all HWIL and range events), time management can not be used

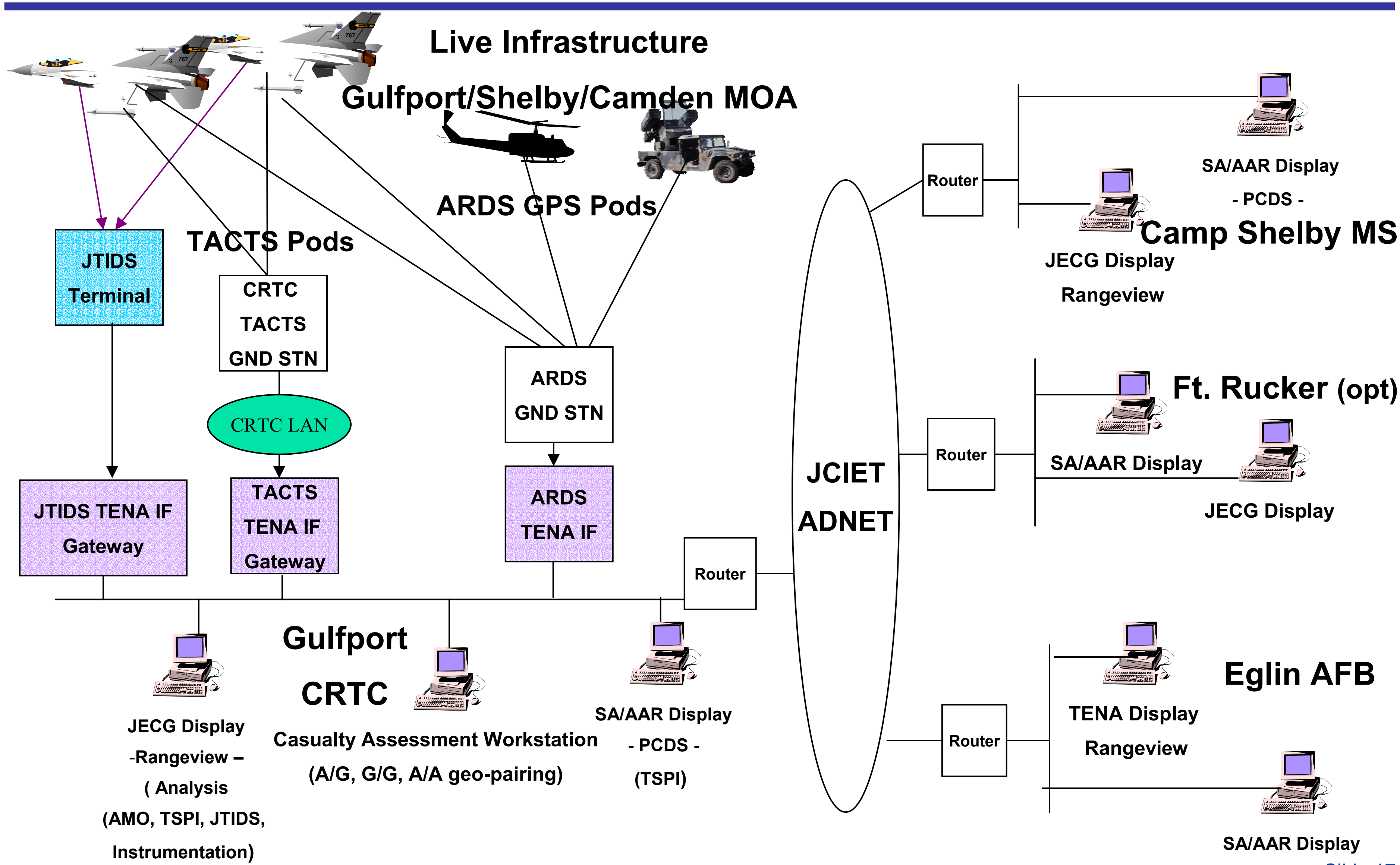
Joint Forces Command (JFCOM) Use of TENA

- Live Data Instrumentation Infrastructure
  - TENA serves at JNTC integration architecture for range interoperability and bridge to simulation network
- Progressive support to JFCOM/JNTC Events:
  - Millennium Challenge 2002 (MC-02)
    - TENA provides common data model via gateways to integrate Range Instrumentation into JTASC GCCS
  - JCIDEX-03
    - Enhanced data model and native TENA interfaces for Range Instrumentation and Analysis Systems for JCID and RTCA assessment
  - WRC Horizontal Thrust Event (HTE)
    - TENA Application Management Object implemented to control Range Instrumentation data feeds and integrate for JCAS assessment
  - CJTFEX-04
    - Reuse of data model and native TENA interfaces for Range Instrumentation and Analysis Systems for JCID and JT&E
  - Joint Red Flag 2005 (JRF-05)
    - Combines: Red Flag 05, Virtual Flag, Roving Sands 05, Battle Group Inport Exercise (BGIE), Joint Systems Training Exercise (JSTE)

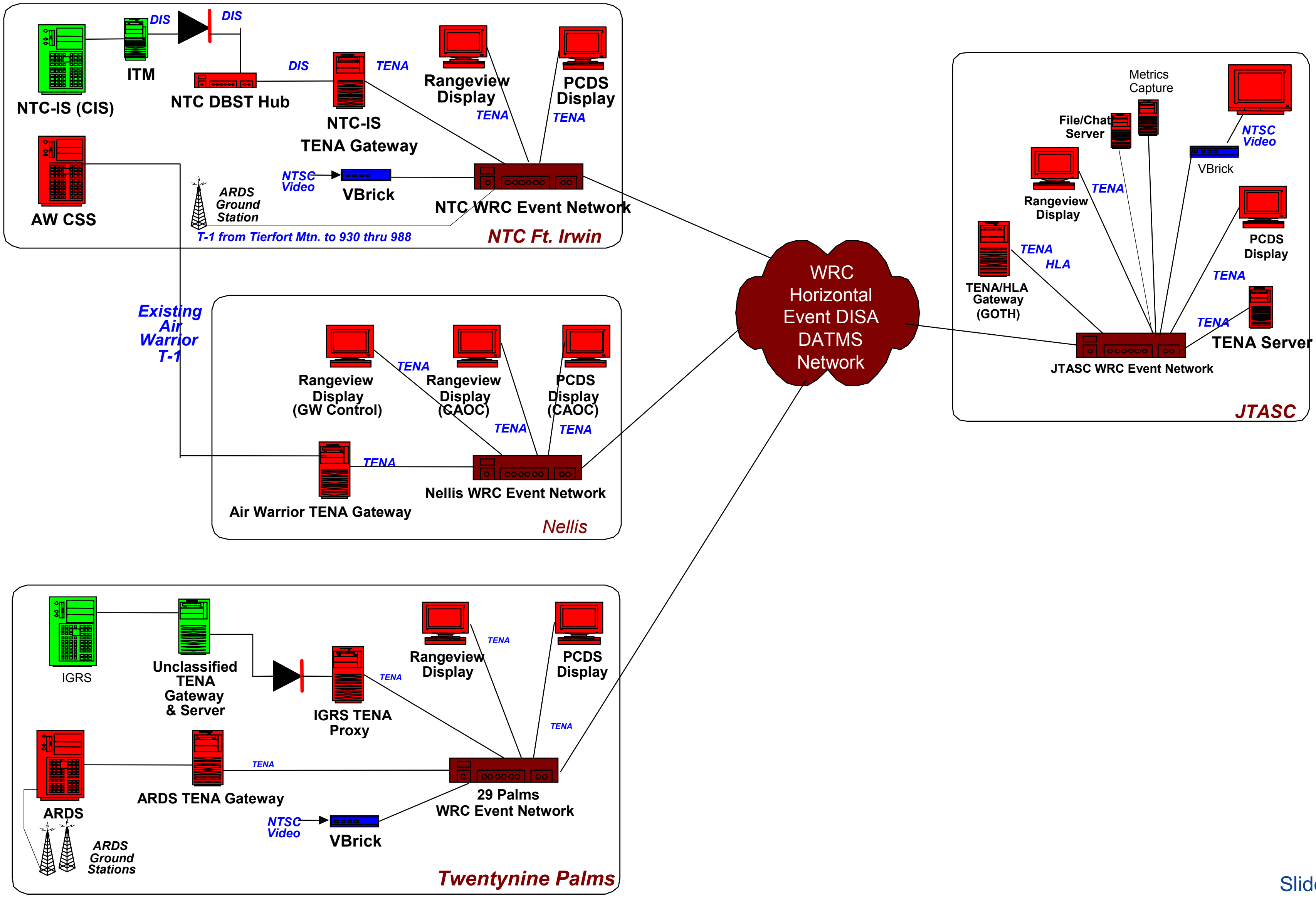
Range Integration in Millennium Challenge 2002 (MC02)



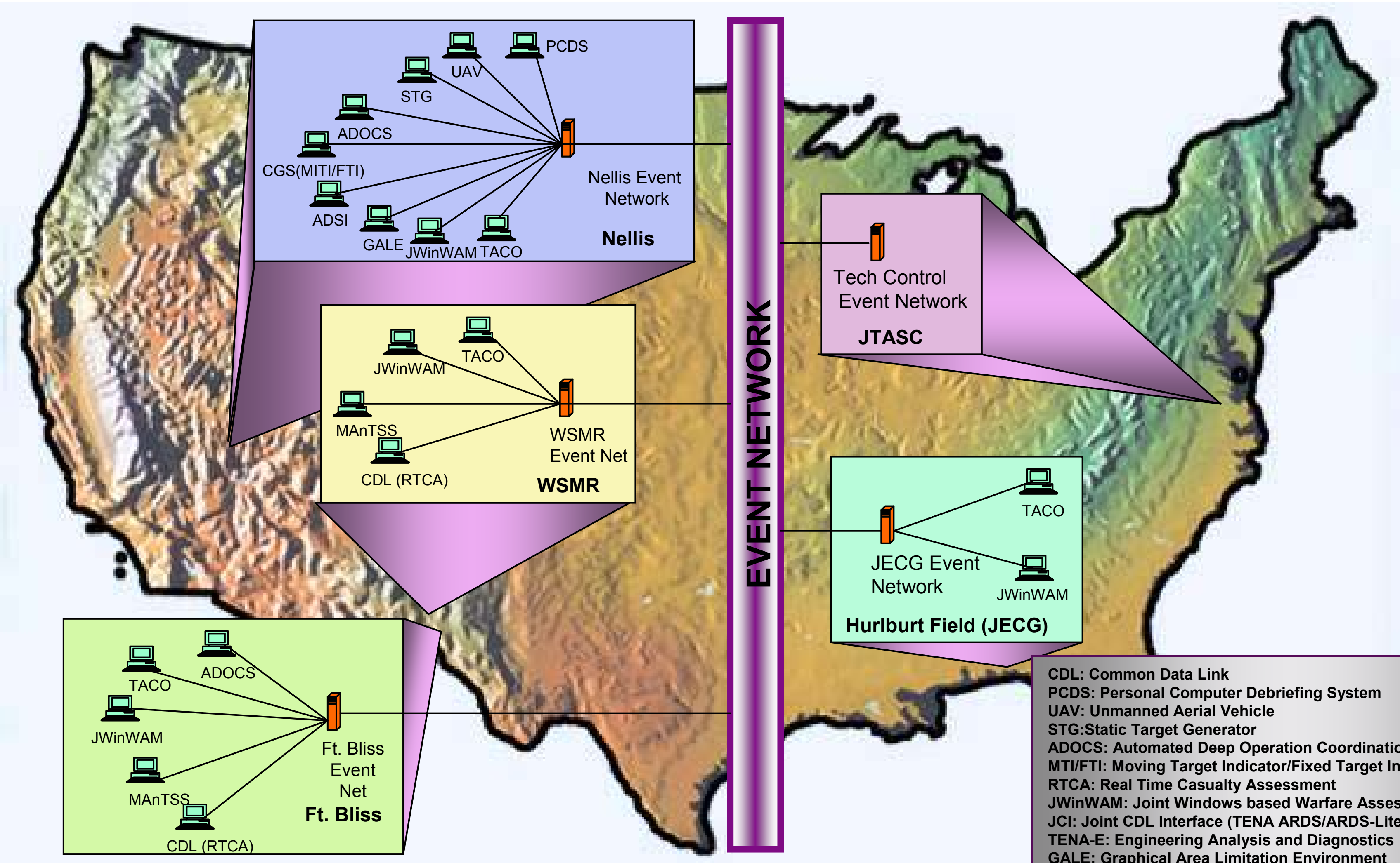
TENA Use in JCIDEX 03



JNTC Horizontal Thrust Event Range Integration Solution



Joint Red Flag 2005



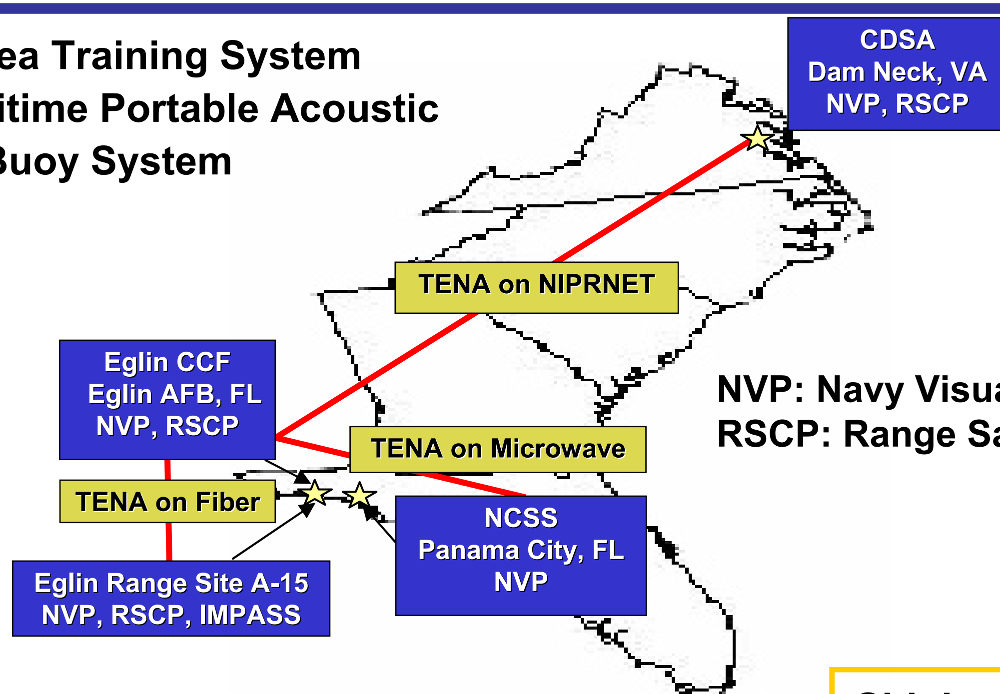
CDL: Common Data Link
PCDS: Personal Computer Debriefing System
UAV: Unmanned Aerial Vehicle
STG:Static Target Generator
ADOCS: Automated Deep Operation Coordination System
MTI/FTI: Moving Target Indicator/Fixed Target Indicator
RTCA: Real Time Casualty Assessment
JWinWAM: Joint Windows based Warfare Assessment Model.
JCI: Joint CDL Interface (TENA ARDS/ARDS-Lite interface)
TENA-E: Engineering Analysis and Diagnostics
GALE: Graphical Area Limitation Environment
MAnTSS: Modular Analysis and Test Support Software (White Cell)
TACO: TACtical Office
CGS: Common Ground Station
ADSI: Air Defense Systems Integrator

Systems Using TENA in JNTC Exercises

- Advanced Range Data System (ARDS and ARDS-Lite) instrumentation interface
- Air Force Air Warrior instrumentation interface
- Army National Training Center Instrumentation System (NTC-IS) instrumentation interface
- Army Test and Evaluation Command engagement adjudication workstation (named the Common Data Link – CDL)
- Automated Deep Operation Coordination System (ADOCS)
- GALAXY A LATR-type system used by the United Kingdom
- JNTC Live-to-Simulation gateway TENA to High Level Architecture application (named GOTH)
- Joint Close Air Support Joint Test & Evaluation COMBAT analysis system and display
- Joint Tactical Information Distribution System (named RAT TRAP)
- Large Area Tracking Range (LATR) system
- Marine Corps Integrated Global Positioning System Radio System (IGRS) instrumentation interface
- NAVAIR After Action Review AAR/Monitor Display (Personal Computer Debriefing System - PCDS)
- Navy Naval Air Systems Command (NAVAIR) RangeView analysis system and display
- Patriot Program Office, Tactical Office (TACO) analysis and display system
- Static Target Generator (STG)
- SureTrak Airspace radar monitoring system
- TENA to Distributed Interactive Simulation (DIS) analysis system (named TOSTADA)
- Time, Space, Position Information (TSPI) Internal Entity Re-formatter (TIER)
- Warfare Assessment Model (WAM) system

VAST / IMPASS
Over-the-Water Scoring

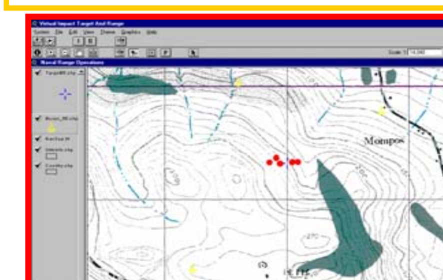
VAST: Navy Virtual At Sea Training System
IMPASS: Integrated Maritime Portable Acoustic Scoring and Simulator Buoy System



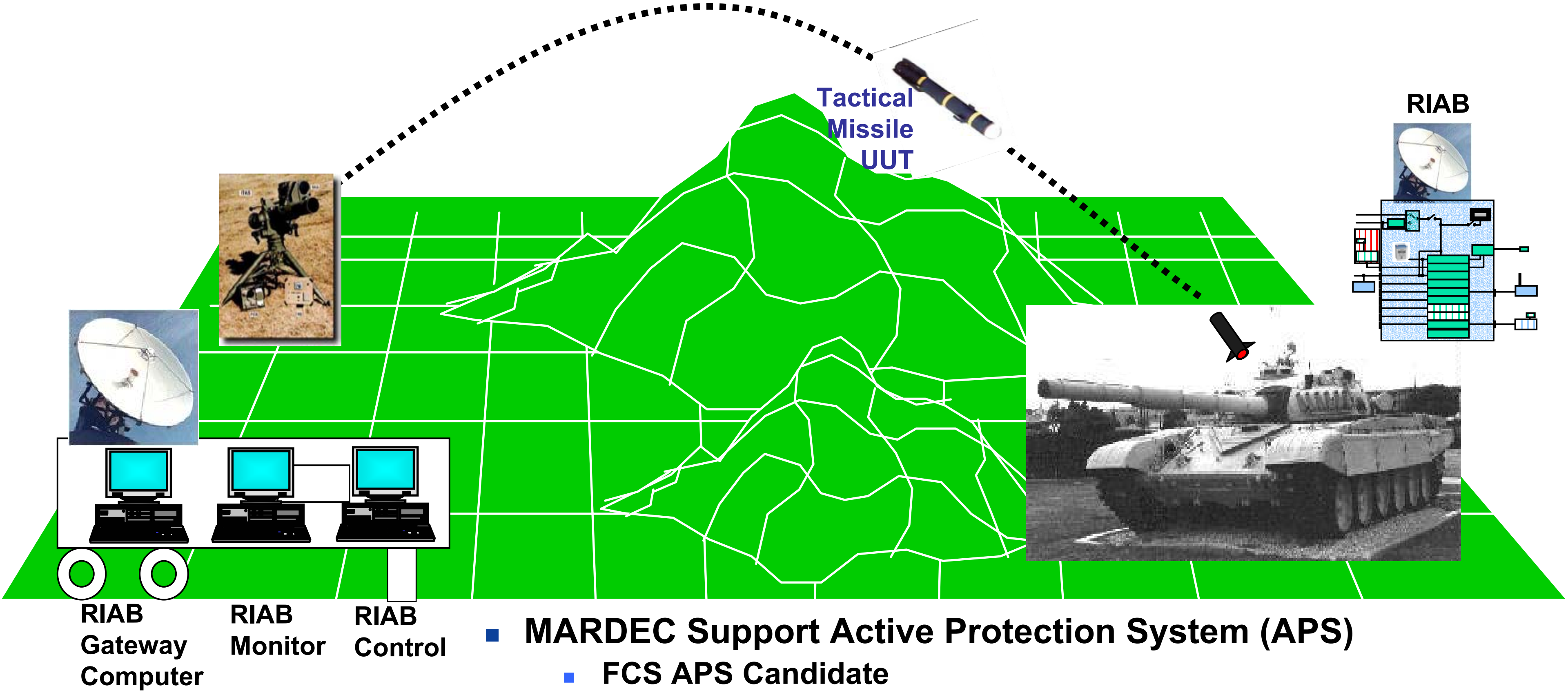
NVP: Navy Visualization Program
RSCP: Range Safety Control Program

GPS
Acoustic Processing
Communication Link

Shipboard Processing
Map Rendering
Virtual Target



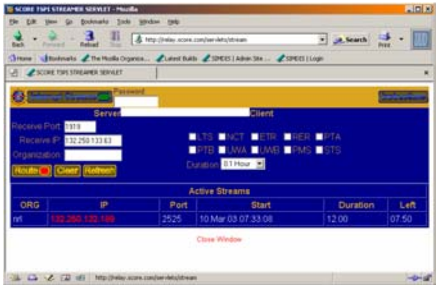
Redstone Technical Test Center Use of TENA



- MARDEC Support Active Protection System (APS)
  - FCS APS Candidate
- "Serial" Connection to RIAB
- TENA Control& Monitor
- Configuration Control in Range Software
- Data Logging via ILH Object

SIMDIS Use of TENA

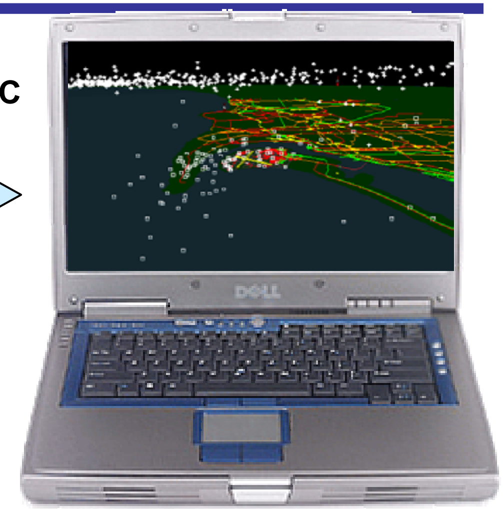
SCORE TSPI Feed



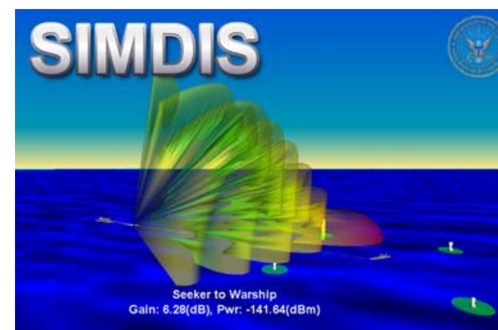
Southern California

TENA

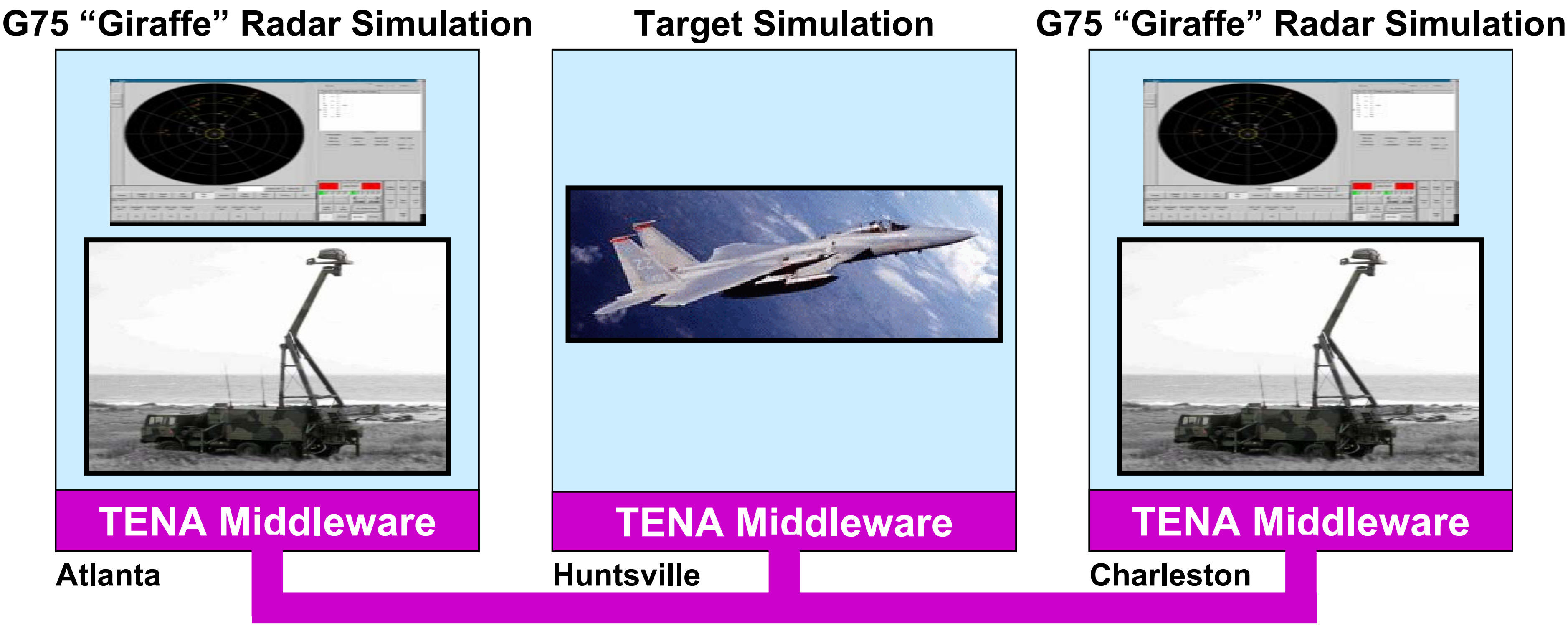
NRL
Washington, DC



- Duration testing using SCORE TSPI data feed
  - Four consecutive days
    - Win XP, Red Hat 9, Solaris 5.8
    - Processed 180,000+ entities
  - Two consecutive days
    - Win XP, Red Hat 9
    - Processed 53,000+ entities
- Results and observations
  - No issues with discovery latency
  - No issues with update latency
  - No issues with CPU usage
  - No issues with memory usage



Threat Systems Test of TENA



- Testing and analysis by Scientific Research Corporation (SRC)
- Results and observations:
  - TENA middleware appears stable and predictable
  - TENA object model format is sufficient for representation of threat systems
  - TENA provides satisfactory functionality and performance to be utilized within a threat simulation scenario and for fielding threat simulations

NetAcquire Using TENA
Real Time Embedded Instrumentation

- **Direct hardware interfaces not standard on COTS desktops**
  - **Aerospace serial I/O formats (synchronous, telemetry, special protocols, etc.)**
  - **GPS (time and position)**
  - **Analog input / output**
  - **Digital and pulse input / output**
  - **IRIG timing**
  - **Avionics buses (1553, ARINC, 1394)**
  - **GPIB (IEEE-488) instrumentation**
  - **Inexpensive, ruggedized, mobile form-factor**

- **Accomplishments:**
  - **Took NetAcquire only 11 days to port TENA into their products**
  - **Direct synchronous serial hardware interface to FPS-16 radar system**
  - **Little or no programming required to support other radar data formats**
- **NetAcquire runs a true real-time operating system, device drivers, and application software**
  - **Provides TENA with deterministic and bounded response times**

The Way Ahead for TENA

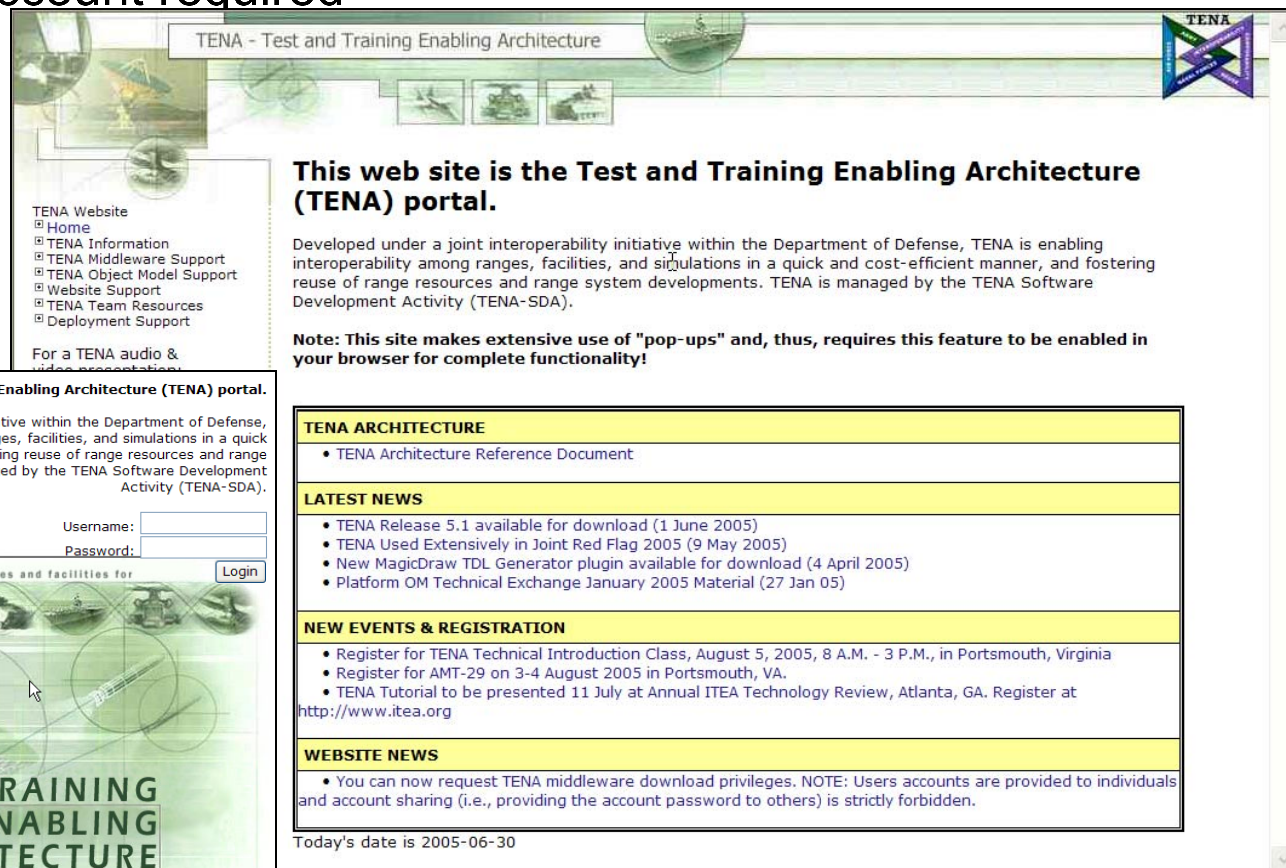
- **Continue partnership Joint National Training Capability (JNTC)**
  - Use the JNTC and JNTC-like events to reduce risk and refine application of TENA
    - Weapons Tactics & Instruction (WTI 06-2)
    - Terminal Fury
    - Talisman Saber
- **Joint Mission Environment Test Capability (JMETC)**
    - Army Cross Command Collaboration (3CE)
    - InterTEC
    - IO Range
    - Cope Thunder
- **Technically support and partner with PMs in their assessment and implementation of TENA for Test and Training applications**
- **Use the current TENA Requirements-Driven and Stakeholder-Prioritized process to spiral develop and prototype further TENA capabilities**

TENA Training Available

- **TENA Technical Overview Course (TOC)**
  - Designed for the non-programmer
  - Provides basic familiarization on TENA and Logical Ranges
  - Lecture format (full day, half day, and two-hour versions available)
- **TENA Technical Introduction Course (TIC)**
  - One day, lecture class for software programmers
  - Introduces design concepts to build TENA-compliant applications
  - 14 classes held to date
    - More than 350 software programmers trained to date
    - Classes held at White Sands, Point Mugu, RTTC, Eglin, Orlando, Alexandria, and London
- **TENA Middleware Hands-on Training (HOT)**
  - Four-day, computer class for software programmers
  - Provides several examples & exercises to learn the TENA Middleware API
  - 12 classes held to date
    - More than 250 software programmers trained to date
    - Classes held at White Sands, Point Mugu, RTTC, Eglin, Alexandria, China Lake, and Dugway (Salt Lake City)

Obtaining & Installing the TENA Middleware and Object Models

- **Get Middleware from the website**
  - http://www.tena-sda.org, log in, go to TENA Middleware Support
  - Registered User Account required



Downloading the TENA Middleware

TENA - Test and Training Enabling Architecture

epowell-approved: profile | logout | ?

Home | Browse Repository | Add Object Model

Middleware: TENA-v5.1

Platform	Filename		
fc3-gcc343-d	TENA-fc3-gcc343-d-v5.1.bin	Download	(54.496MB)
fc3-gcc343	TENA-fc3-gcc343-v5.1.bin	Download	(27.424MB)
irix65-mipspro742m-d	TENA-irix65-mipspro742m-d-v5.1.bin	Download	(37.801MB)
irix65-mipspro742m	TENA-irix65-mipspro742m-v5.1.bin	Download	(21.75MB)
rh8-gcc32-d	TENA-rh8-gcc32-d-v5.1.bin	Download	(132.572MB)
rh8-gcc32	TENA-rh8-gcc32-v5.1.bin	Download	(40.312MB)
rh9-gcc322-d	TENA-rh9-gcc322-d-v5.1.bin	Download	(132.661MB)
rh9-gcc322	TENA-rh9-gcc322-v5.1.bin	Download	(40.548MB)
rhelws4-gcc343-d	TENA-rhelws4-gcc343-d-v5.1.bin		
rhelws4-gcc343	TENA-rhelws4-gcc343-v5.1.bin		
solaris8-gcc323-d	TENA-solaris8-gcc323-d-v5.1.bin		
solaris8-gcc323	TENA-solaris8-gcc323-v5.1.bin		
2k-vc71-d	TENA-2k-vc71-d-v5.1.exe	Download	(59.581MB)
2k-vc71	TENA-2k-vc71-v5.1.exe	Download	(24.365MB)
xp-vc71-d	TENA-xp-vc71-d-v5.1.exe	Download	(59.512MB)
xp-vc71	TENA-xp-vc71-v5.1.exe	Download	(24.361MB)

File Download - Security Warning

Do you want to run or save this file?

Name: TENA-xp-vc71-d-v5[1].1.exe
Type: Application, 59.5 MB
From: www.tena-sda.org

Run | Save | Cancel

While files from the Internet can be useful, this ...

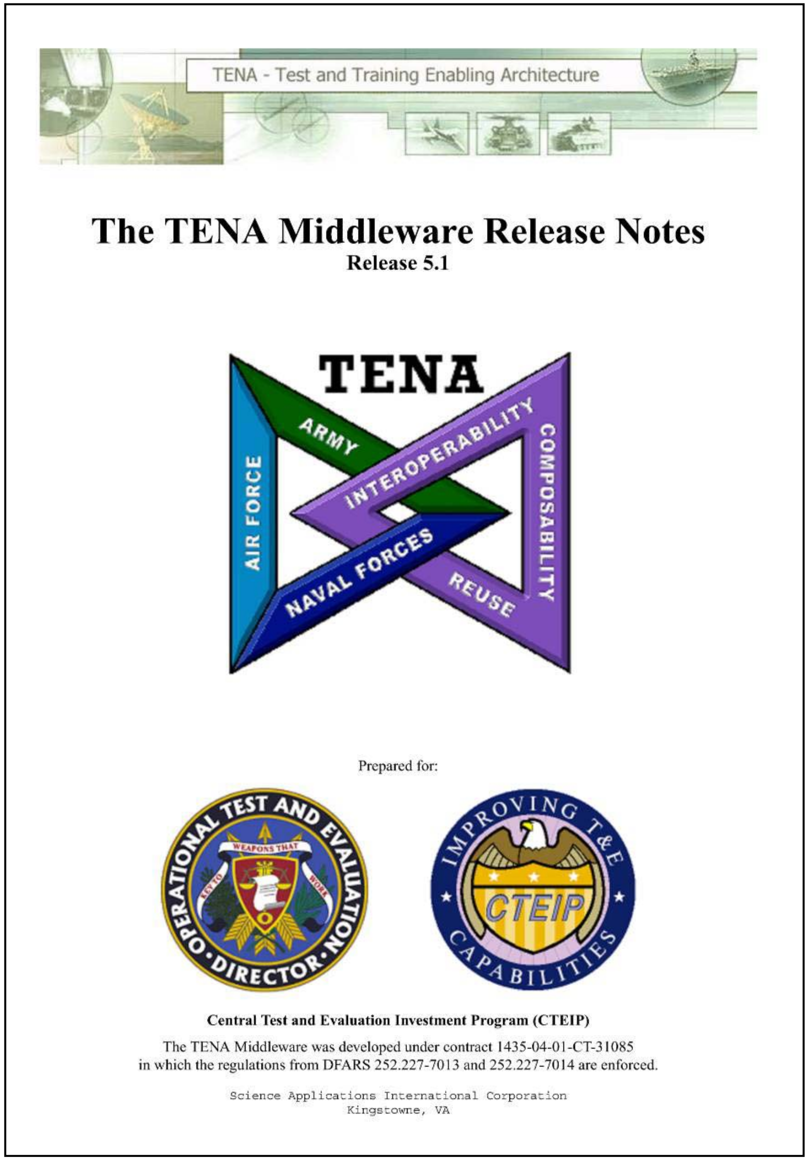
Download stats for Q4/2005:

- **~500 middleware downloads**

TENA Supported Platforms

Operating System	Compiler Type	Status
Embedded Planet (Linux Real-Time OS)	GCC 3.2.2	Supported **(5.1.1 release)**
Linux - Fedora Core 3	GCC 3.4.3	Supported
Linux - Fedora Core 4	GCC 4.0.1	Supported **(5.1.1 release)**
Linux - Red Hat 8.0	GCC 3.2	Supported
Linux - Red Hat 9.0	GCC 3.2.2	Supported
Linux - Red Hat Enterprise WS 4	GCC 3.4.3	Supported
Phar Lap ETS - NetAcquire (HW integrated Windows Real-Time OS)	MS Visual C++ 7.1	Supported (through CRADA with NetAcquire)
SGI IRIX 6.5.22m	GCC 3.3	Supported
Solaris 8	GCC 3.2.3	Supported
Solaris 10	Sun SPRO 5.8 (w/wo 64 bit mode)	Supported **(5.1.1 release)**
Windows 2000	MS Visual C++ 7.1	Supported
Windows XP	MS Visual C++ 7.1	Supported
MAC OS 10.4.2	GCC 3.3	Unable to support with 5.1.1 release due to TAO 1.3 incompatibility, will add when TAO is upgraded
VxWorks 6.1	GCC 3.3.2	Port in progress

Installing the Release



The TENA Middleware Release Notes

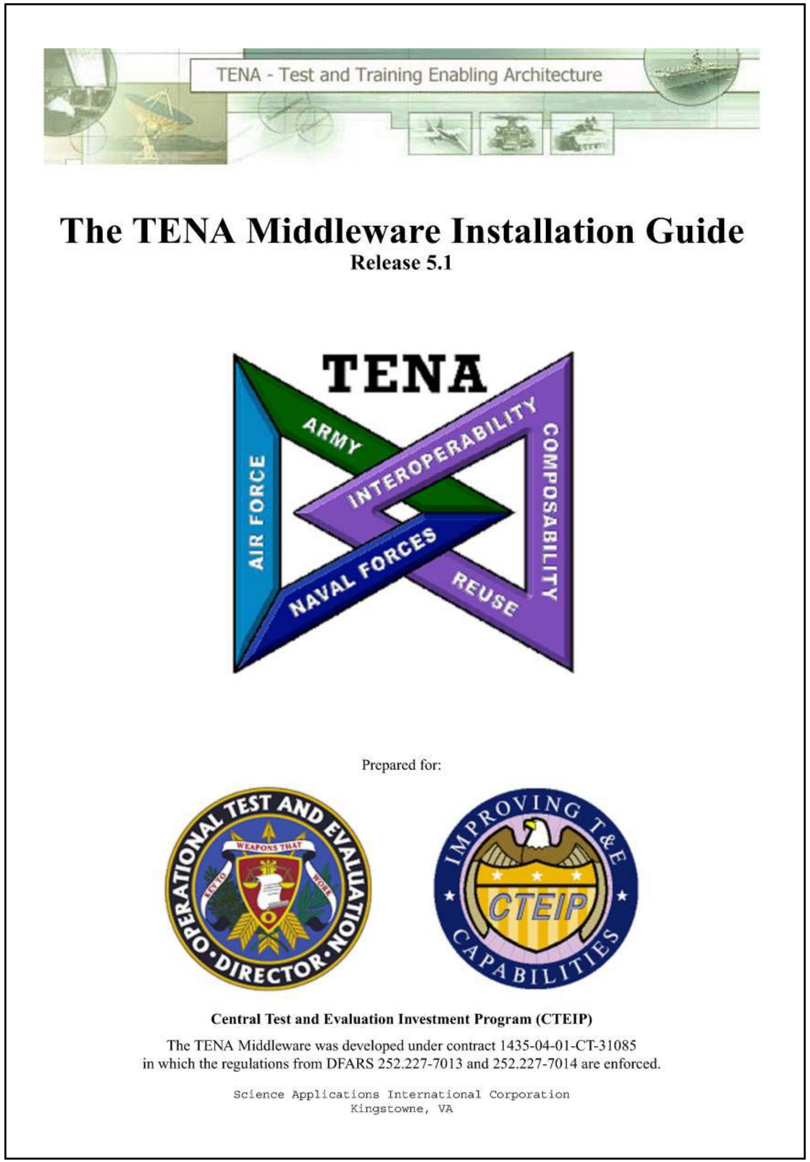
Release 5.1

Prepared for:

Central Test and Evaluation Investment Program (CTEIP)

The TENA Middleware was developed under contract 1435-04-01-CT-31085
in which the regulations from DFARS 252.227-7013 and 252.227-7014 are enforced.

Science Applications International Corporation
Kingstowne, VA



The TENA Middleware Installation Guide

Release 5.1

Prepared for:

Central Test and Evaluation Investment Program (CTEIP)

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in which the regulations from DFARS 252.227-7013 and 252.227-7014 are enforced.

Science Applications International Corporation
Kingstowne, VA

TENA Standard Object Models

- **TENA-Platform:**
  - TENA-Platform-v3.1
  - TENA-PlatformDetails-v3
  - TENA-Affiliation-v1
  - TENA-UniqueID-v2
  - TENA-PlatformType-v1
  - DIS-EntityType-v1
  - TENA-Munition-v2.1
  - TENA-Engagement-v3.1
  - TENA-Organization-v1
  - TENA-EmbeddedSystem-v2
  - TENA-EmbeddedSensor-v2
  - TENA-EmbeddedWeapon-v2
- **TENA-AMO:**
  - TENA-AMO-v1
- **TENA-TSPI:**
  - TENA-TSPI-v4
  - TENA-Time-v1.1
  - TENA-Position-v1
  - TENA-Velocity-v1
  - TENA-Acceleration-v1
  - TENA-Orientation-v1
  - TENA-AngularVelocity-v1
  - TENA-AngularAcceleration-v1
  - TENA-ORM-v1
  - TENA-SRF-v1
  - TENA-SRFserver-v1

TENA-TSPI-v4

(TENA SDA Supported)

<<TENA::LocalClass>>
TSPI

<<TENA::LocalClass>>
Time

<<TENA::LocalClass>>
Velocity

<<TENA::LocalClass>>
Acceleration

<<TENA::LocalClass>>
Orientation

<<TENA::LocalClass>>
Position

-p1 : TENA::double
-p2 : TENA::double
-p3 : TENA::double
-srf : SRFenum
-srfData : TENA::double [0..*]
-orm : ORMenum

+get_GeocentricPosition(srf : GeocentricSpatialReferenceFrame) : GeocentricPosition
+set_GeocentricPosition(pos : GeocentricPosition, srf : GeocentricSpatialReferenceFrame) : TENA::void
+get_GeodeticPosition(srf : GeodeticSpatialReferenceFrame) : GeodeticPosition
+set_GeodeticPosition(pos : GeodeticPosition, srf : GeodeticSpatialReferenceFrame) : TENA::void
+get_LocalTangentPlaneENUposition(srf : LocalTangentPlaneENUspatialReferenceFrame) : LocalTangentPlaneENUposition
+set_LocalTangentPlaneENUposition(pos : LocalTangentPlaneENUposition, srf : LocalTangentPlaneENUspatialReferenceFrame) : TENA::void
+get_LocalSphericalTangentPlanePosition(srf : LocalSphericalTangentPlaneSpatialReferenceFrame) : LocalSphericalTangentPlanePosition
+set_LocalSphericalTangentPlanePosition(pos : LocalSphericalTangentPlanePosition, srf : LocalSphericalTangentPlaneSpatialReferenceFrame) : TENA::void
+get_SRF() : SpatialReferenceFrame

<<TENA::LocalClass>>
GeocentricPosition

+x : TENA::double
+y : TENA::double
+z : TENA::double

<<TENA::LocalClass>>
GeodeticPosition

+latitude : TENA::double
+longitude : TENA::double
+heightAboveEllipsoid : TENA::double

<<TENA::LocalClass>>
LocalTangentPlaneENUposition

+x : TENA::double
+y : TENA::double
+z : TENA::double

<<TENA::LocalClass>>
LocalSphericalTangentPlanePosition

+elevation : TENA::double
+azimuth : TENA::double
+range : TENA::double

TENA Solutions to Interoperability Challenges

- **On-the-Wire Specification vs. API Standard**
  API Standard allows future technological advances for data transmission to be much more cost-effectively incorporated
- **Single Reference Frame vs. Multiple Reference Frames**
  Multiple Reference Frames allow different range systems to operate in the coordinate system most optimum for their range
- **Single Level vs. Multiple Levels of Compliancy**
  Multiple Levels of Compliancy allow a more meaningful definition of compliancy to be used among Range engineers & investment managers
- **Run-Time Interpreter vs. Compile-Time Integration**
  Compile-Time Integration allows for inconsistencies to be discovered when the software is being upgraded vice during the event
- **Hand-Coded vs. Auto-Code-Generated Interfaces**
  Auto-Code-Generated Interfaces can be produced more reliably and tremendously faster than traditional hand-coded interfaces

Summary

TENA is an <u>Architecture</u> for Ranges, Facilities, and Simulations to Interoperate, to be Reused, to be Composed into greater capabilities

- TENA can be downloaded from the Web (for free)
  - TENA Middleware currently works on Windows, Linux, and Sun
- Users are involved in the process to develop and expand the architecture
  - CTTRA Workshops, AMT Meetings, and RCC Coordination
- TENA is the JNTC architecture for Live integration
- TENA is being used in a number of applications including vendor instrumentation systems

Important Contact Information

- **Project Website: http://www.tena-sda.org**
  - Download TENA Middleware
  - Submit Helpdesk Case (http://support.fi2010.org)
- **TENA Architecture Reference Document**
  - http://www.tena-sda.org/documents/tena2002.pdf
- **TENA Feedback: feedback@tena-sda.org**
  - Provide technical feedback on TENA Architecture or Middleware
  - Ask technical questions regarding TENA
  - Provide responses to AMT action items
  - Request TENA training

Non-Technical Obstacles to Effective M&S Connectivity in Support of T&E

Panel Chair: Mr. John Illgen

Northrop Grumman Simulation Technologies

Introduction

- **Greetings**
- **Introduction of Panel Members**
  - John Illgen, Northrop Grumman
  - Dr. Paul Deitz, ARL
  - Mr. Rick Cozby, DTC
  - Mr. Jack Sheehan, FCSCTO
  - Mr. Augie Ponturiero, Northrop Grumman

A Changing Landscape

- **Capabilities-Based Acquisition**
  - Warfighter-focused
  - New thought processes on WHY, WHAT, and HOW to develop new Systems/Families of Systems/Systems of Systems
- **New Systems/Families of Systems "Born Joint"**
  - Services working together at all levels to bring capabilities to the Warfighters
- **Funding Constraints**
  - New Developments vs Current Operations Support
  - Using more Virtual and Constructive entities for testing

    M&S more significant in Test and Evaluation

The Effect

- **Increased cooperation between Services and DoD Agencies at all levels**
- **Multi-Service and Joint Testing**
  - OSD-driven – “Testing in a Joint Environment Roadmap”
    - What is the impact to Service Acquisition efforts?
- **PM, T&E, Warfighters must work together across Service boundaries to field new systems**
  - T&E communities need to understand one another first!
- **T&E Communities forging closer working relationships**
  - Different priorities
  - “Cultural” and “Language” differences

Today’s Discussion

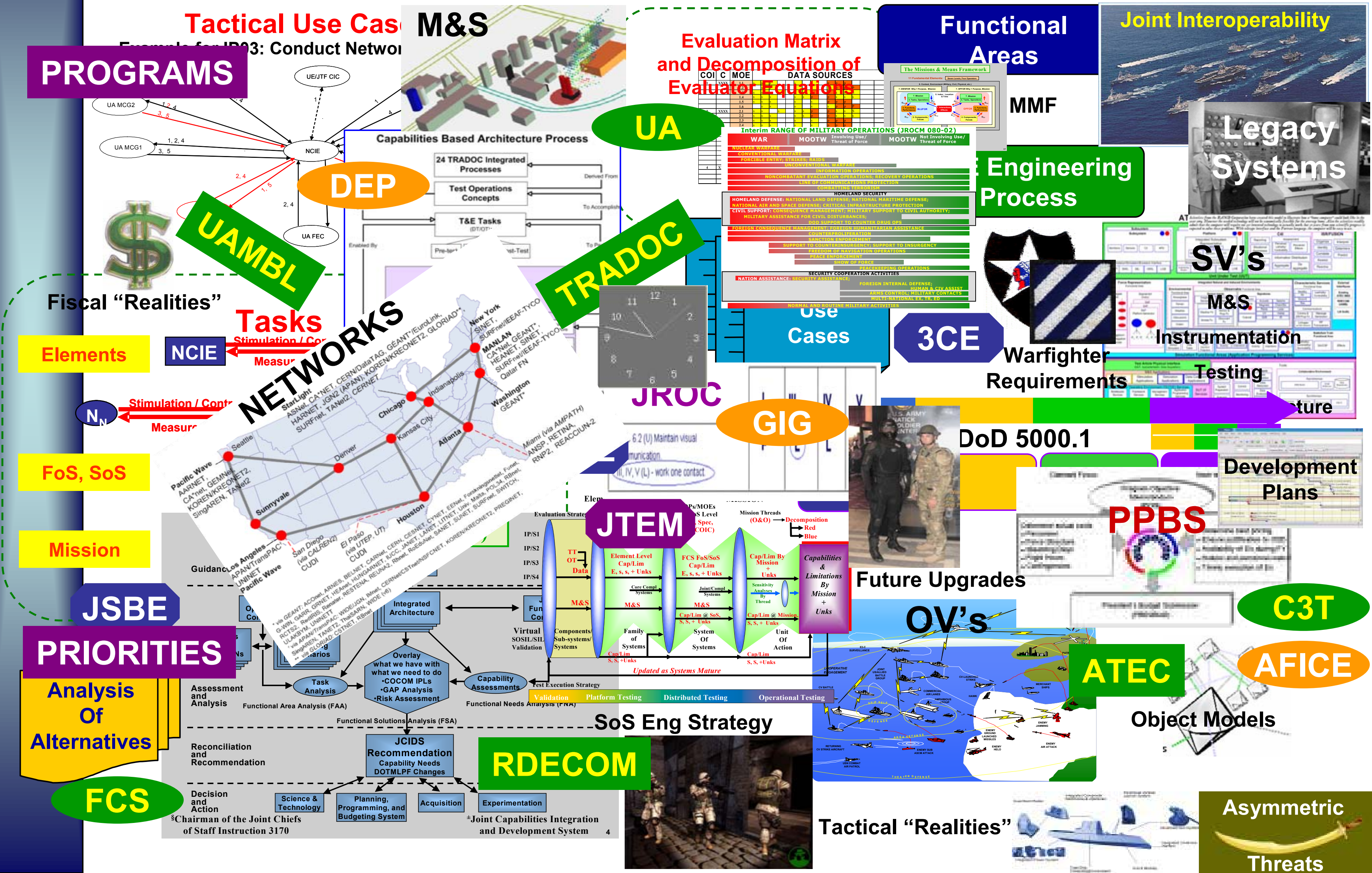
NDIA

- **Look at the Non-Technical issues affecting T&E**
- **T&E Communities forging closer working relationships**
  - Different priorities
  - “Cultural” and “Language” differences
- **Multi-Service and Joint Testing**
  - OSD-driven – “Testing in a Joint Environment Roadmap”
    - What is the impact to Service Acquisition efforts?
- **PMs, T&E, Warfighters must work together across Service boundaries to field new systems**
  - First Step: T&E Communities must work together and speak the same language

Non-Technical Factors Affecting T&E Interoperability

Mr. Augustine J. Ponturiero
Northrop Grumman Simulation Technologies

The Problem:
How to clarify Lifecycle issues in a T&E context?



Challenges

- **Systems of Systems (SOS)/Families of Systems (FOS)**
  - Network Enabled Systems
  - Network Centric Enterprise Services
  - Global Information Grid
  - Joint Command and Control (JC2)
  - Multi-National Information Sharing
- **Missions and Scenarios Paradigm Shift**
  - Transform from forces-based, materiel-centric Cold War to capabilities-based, mission centric asymmetric-warfare posture
- **Joint Focus**

What is the “force multiplier?” How do we define it?

Non-Technical Factors
T&E Community Issues

- **“Ad Hoc” Processes**
  - Rely on individuals, not processes, to successfully complete events
- **Common Tools**
  - Few
  - Not used effectively
  - Gap in tools available for collaboration and communication
- **Not familiar with other Services**
- **No effective Network Engineering Process**
- **Insufficient process maturity to be “repeatable”**

Must make a Cultural Change within the T&E Community

A Cultural Change

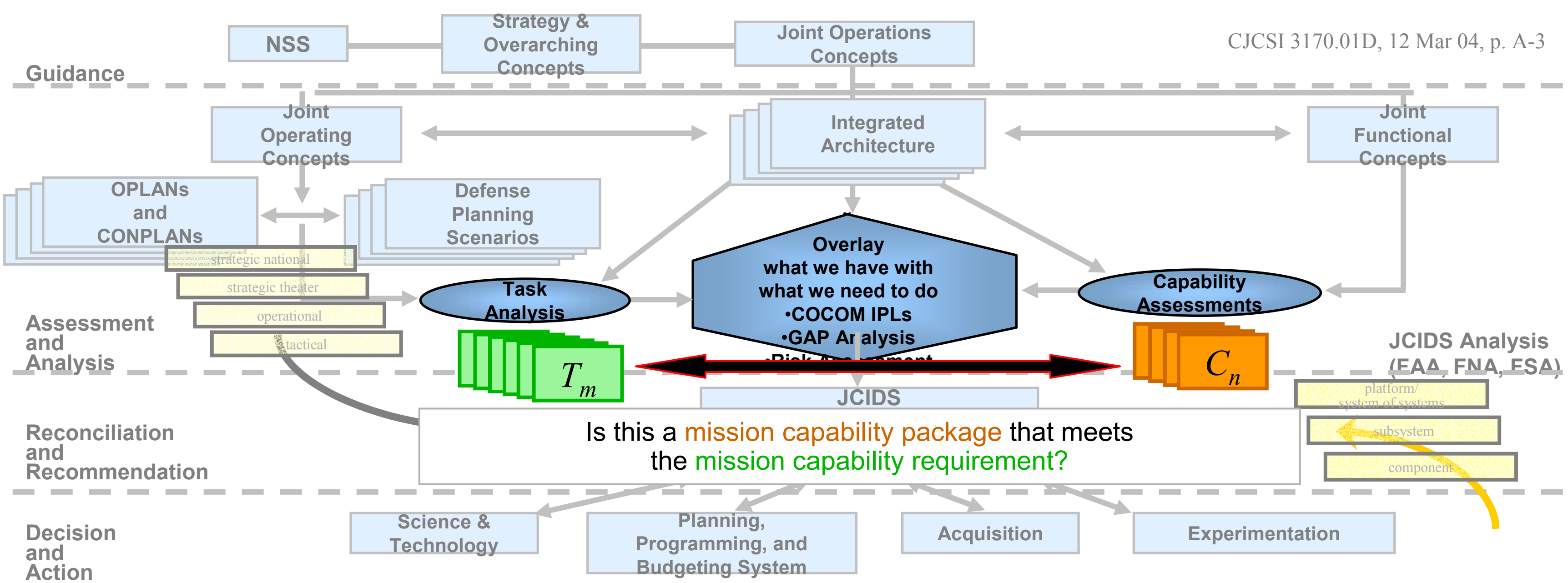
- **Joint vice Service focused testing**
- **Shared Models and Simulations**
  - "Users won't use the model correctly and it will reflect badly on me/us…"
- **Improved understanding of Joint Test environment including Network and Security strengths and limitations**
  - Navy = Air Force = Army = Marines
- **Improved community-wide methods and processes**
  - JTEM is taking the first steps
  - Sustainable, Repeatable, Consistent, Understandable results
  - Operations and Acquisitions context

The Benefit:
Better Info to Decision-Makers, Faster

- Operational and Acquisition Leadership
- Better analysis of alternatives for acquisition decisions
- Clearer understanding of test results across T&E and Operations Spectrum
- Shared data and information – faster analysis and recommendations
- Virtual Environment for testing
- Capability-based assessment of system
- Examination of proposed systems from a Doctrine/Operations/Training perspective early in development.
- Common "language", data, and processes between Acquisition, T&E, and Ops Communities
- Common understanding between Acquisition, Ops, and T&E Communities

Capabilities-Based Development
The Missions and Means Framework

- The LINK between the Military Decision Making Process and the domain of DOTMLPF solutions
- A WARFIGHTER-FOCUSED STRUCTURE for rigorous, complete, and detailed analysis in crucial evaluation programs
- An ORGANIZING PRINCIPLE for requirements, test planning, and evaluation



Application of the Missions and Means Framework to Distributed Testing: Some Results From A Test

Mr. Richard S. Cozby

Chief, Technology Management Division

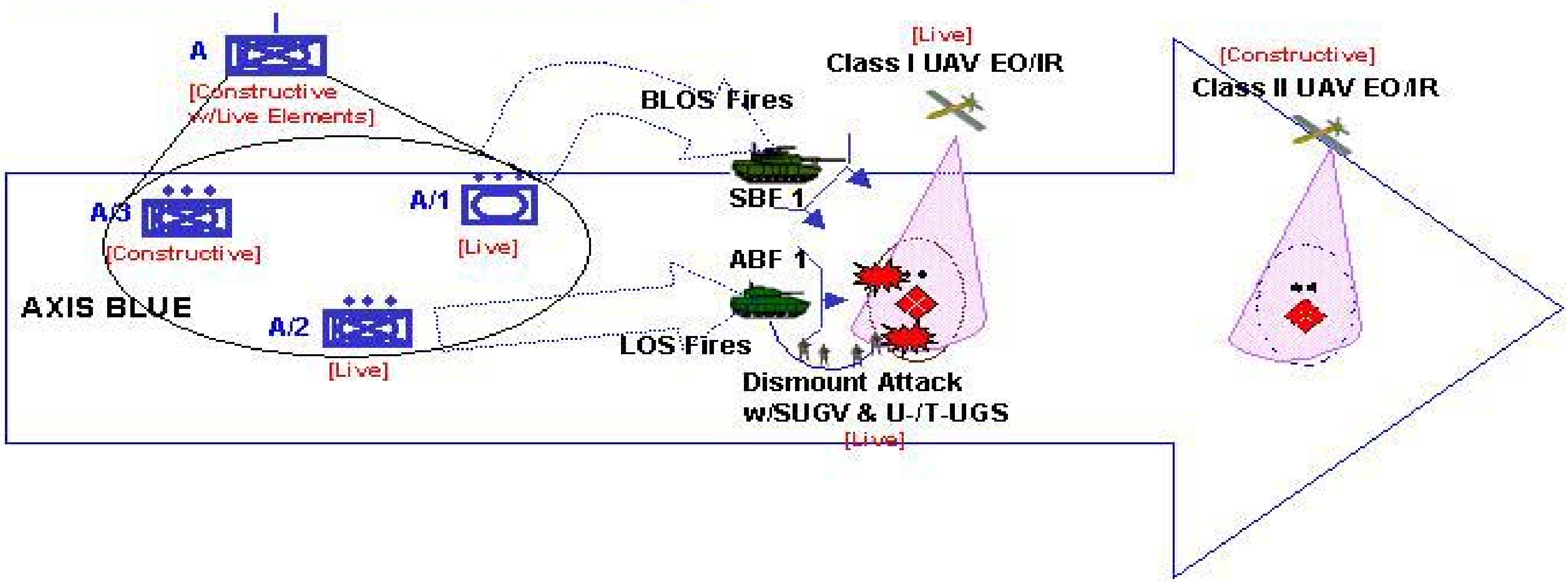
HQ, U.S. Army Developmental Test Command

Distributed Test Event-5/Multi-Service Distributed Event

Event: August 2005
Mission Context: A Company Mounted Operation Supported by Platoon Dismounted Forces in an Urban Environment

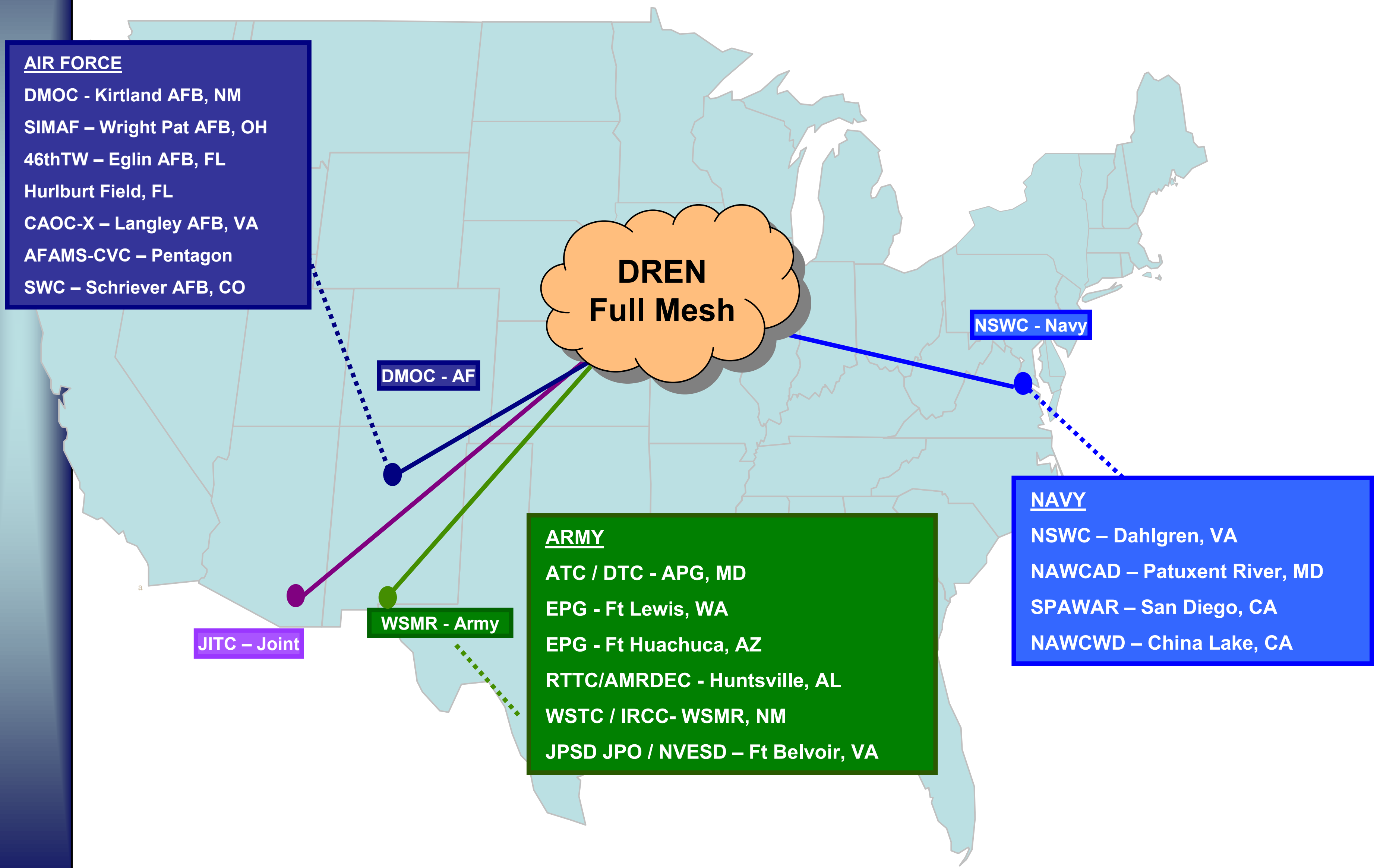
Step 1: Alpha Team (2 ICV & 1 MCS PLTs) moves along AXIS BLUE. Enemy dismount force is detected by A TM's Class II UAV in town. ICV PLT identifies enemy flank, and formulates & disseminates plan to all Soldiers. MCS PLT moves to SBF position. ICV PLT moves to secure locations & deploys Class I UAV, SUGV, and T-UGS. ICV PLT dismounts and attacks with direct fire & movement; deploys U-UGS. ICVs & weapons squads provide supporting LOS fires. MCS PLT provides supporting BLOS fires.

Step 2: Enemy force in town is defeated or captured. ICV PLT secures objective, and consolidates & reorganizes. Dismount PLT LDR transmits situation report & requests MEDEVAC support. MCS PLT covers dismount movement to ICV remount locations. ICV PLT quickly remounts ICVs. ICV PLT LDR updates SA for all Soldiers. MCS Class II UAV detects and identifies another dismounted force. Alpha Team continues attack along AXIS BLUE.

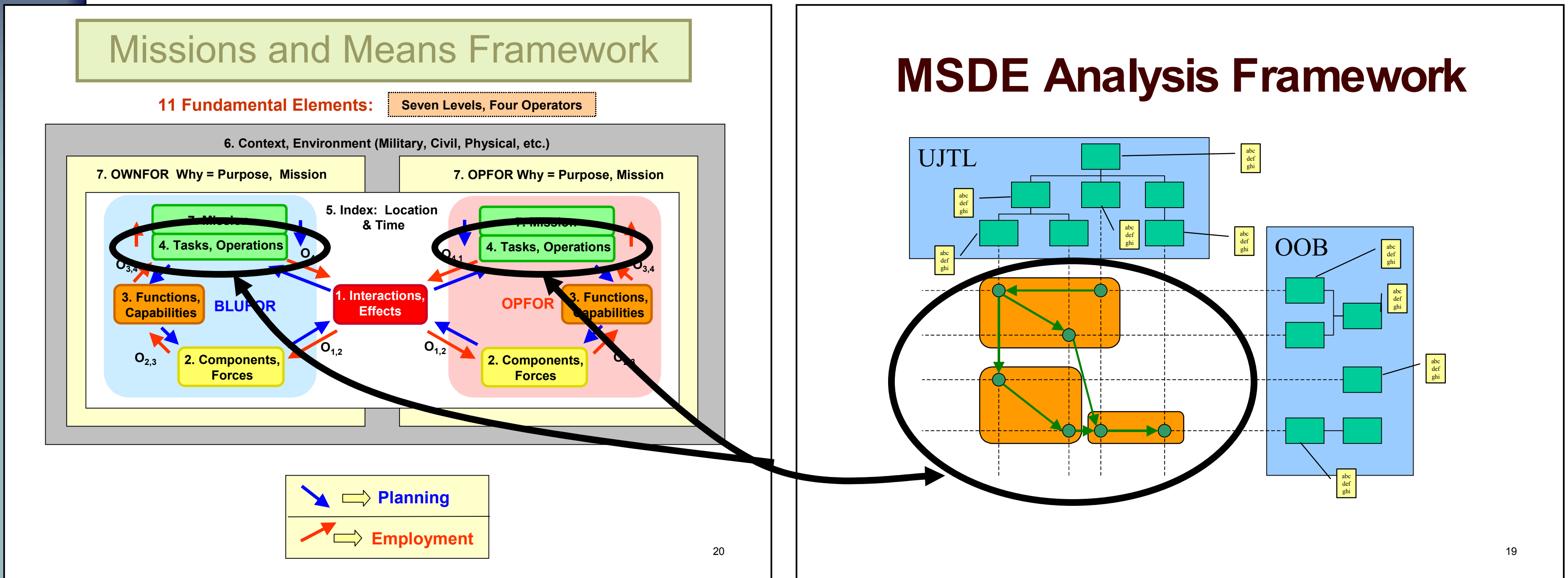


Event Joint Mission Context

Participants



Event Analysis Framework



- Use Joint Tactical Tasks to define the operation
- Decompose the tasks to understand component-level influences
- Instrument the components to measure their activities
- Synthesize the tasks as a manifestation of component interactions

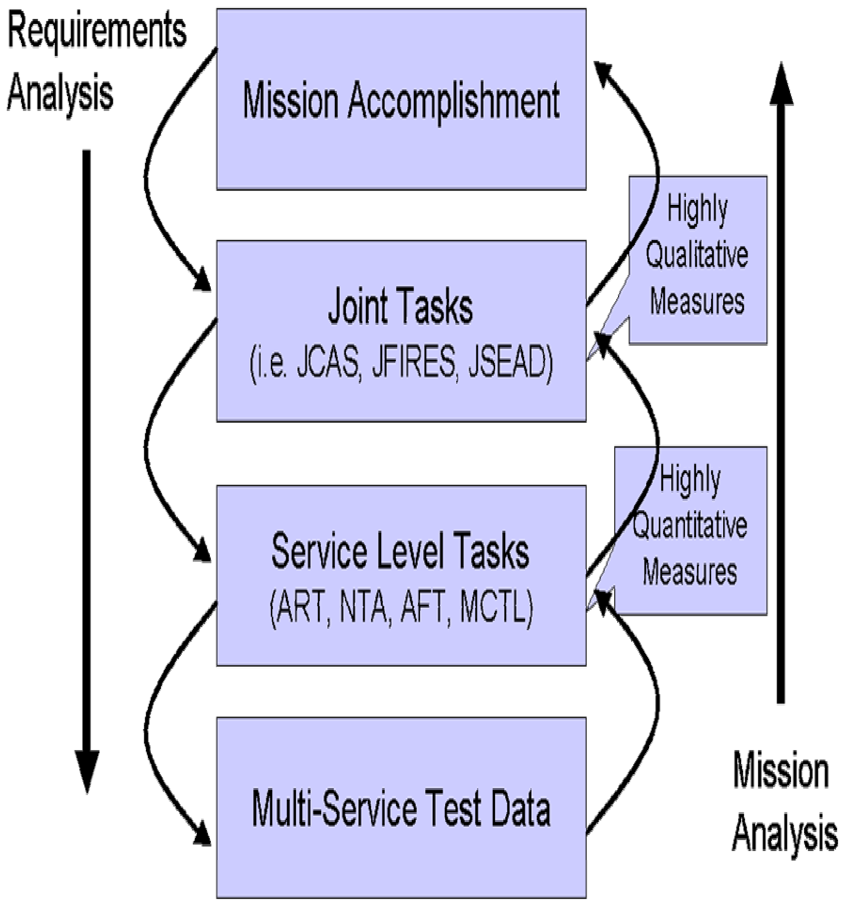
Event Analysis Methodology

NDIA

ANALYSIS PRODUCTS

- Baseline analysis methodology for assessment of Joint Tasks
- Baseline set of Joint Task Measures associated with each Service Level Task (NTA, ART, AFT, MCTL)
  - Quantitative Data Examples
    - ART 1.4.3 - M3 - Time to make initial assessment of attacks after TOT
    - NTA 3.2.2 – M2 – Minutes after target ID to complete attack
    - AFT 2.1.1 – M1 – Time from the desired timing for lethal force to cause desired effects
- System level measures for respective service test objectives

MULTI-SERVICE JOINT TASK COMMON ANALYSIS METHODOLOGY



Results and Areas for Improvement

- **Demonstrated ability to execute a distributed L/V/C event with existing capabilities.**
- **Conducted system testing in the context of a Joint mission.**
- **Gained experience with multi-Service performance report generation using multiple tools.**
- **Gained experience in reporting complex Joint thread exercises with diverse data formats.**

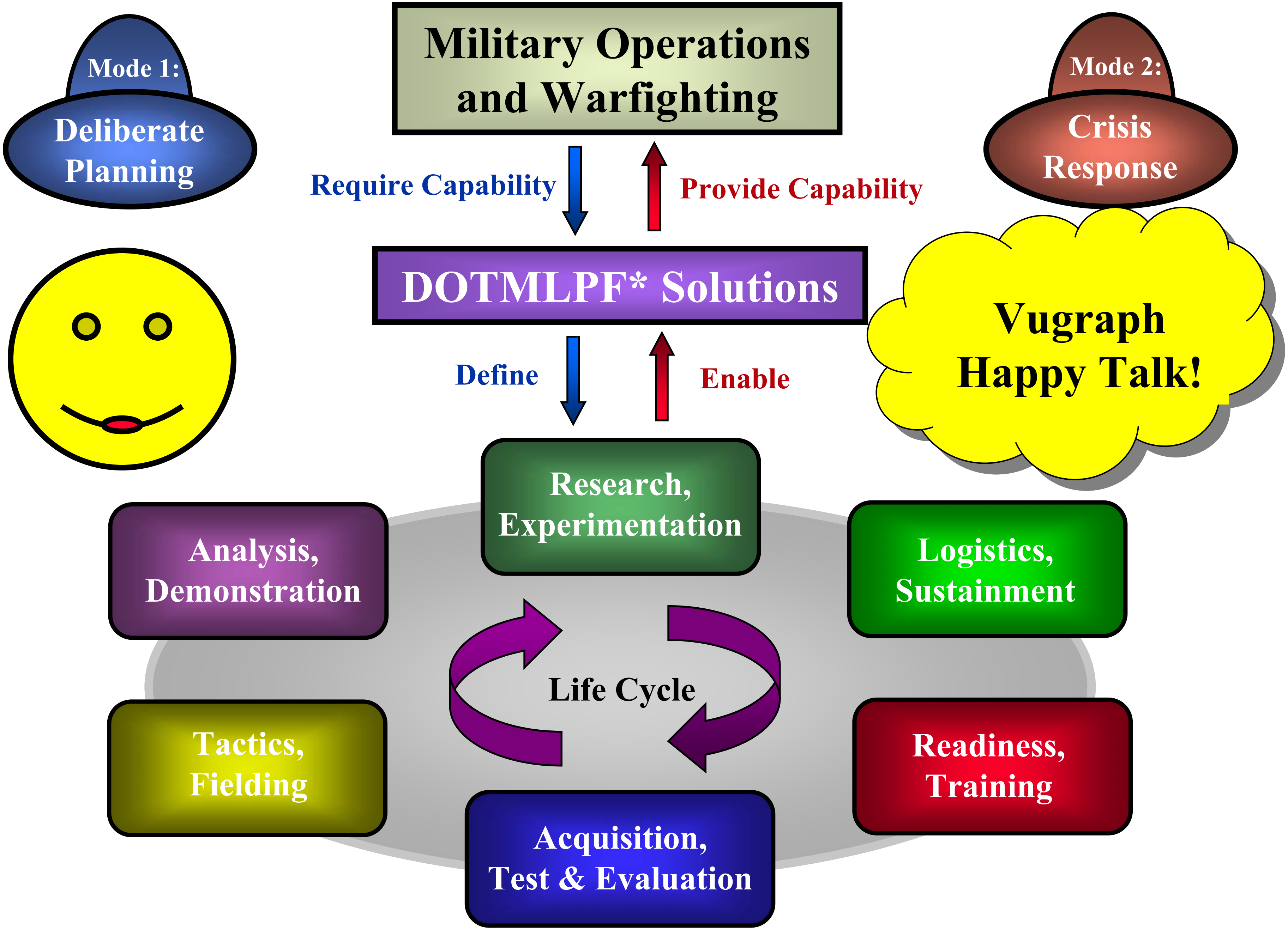
	Areas Requiring Improvement	Assessment
1	Ability to determine system contributions to the accomplishment of a Joint task.	
2	Ability to evaluate individual test item performance in L/V/C events.	
3	Ability to test multiple items in a Joint environment simultaneously and accomplish all test objectives.	
4	Ability to sufficiently gather, process, and analyze data (one set) from distributed L/V/C events.	
5	Determine capabilities and limitations associated with legacy systems in Joint L/V/C events.	
6	Integrate across a variety of environment models and coordinate systems.	
7	Assess and integrate multiple threat representations in a distributed L/V/C environment	

Getting Organized to Perform Evaluation

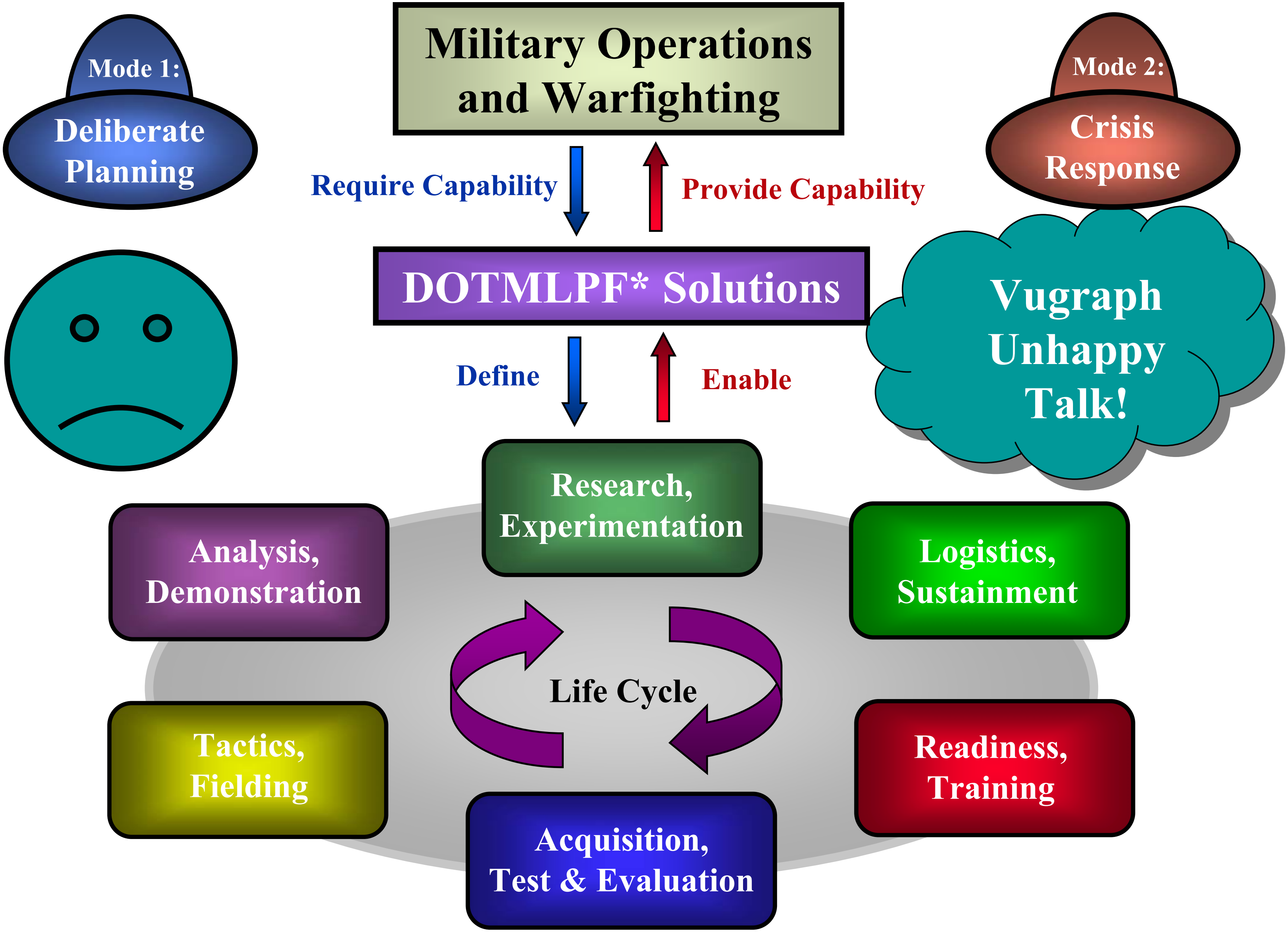
Dr. Paul H. Deitz

Director (A)

Human Research & Engineering Directorate,
U.S. Army Research Laboratory



* DOTMLPF: Doctrine, Organization, Training, Materiel, Leader Development, Personnel, Facilities



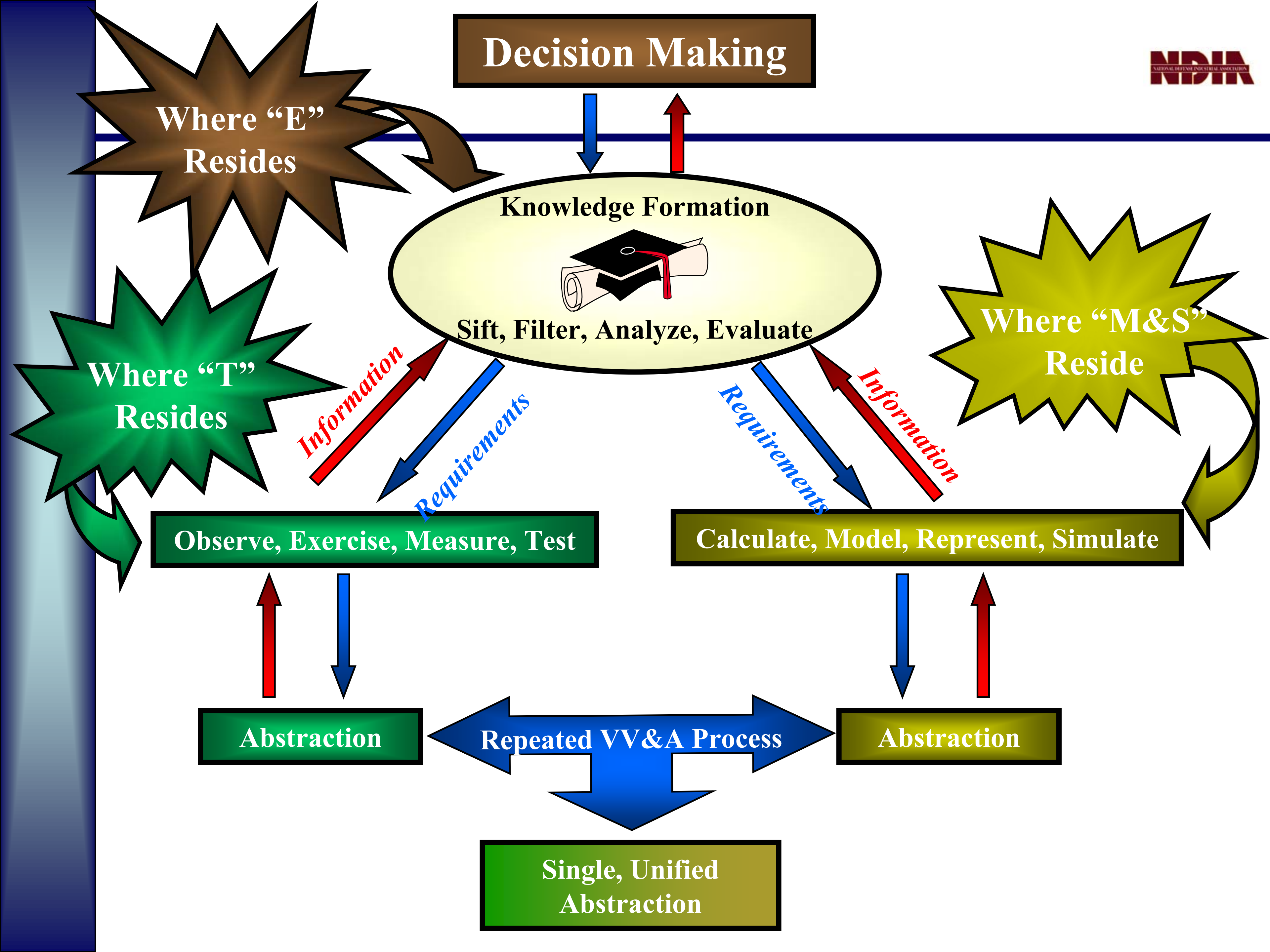
* DOTMLPF: Doctrine, Organization, Training, Materiel, Leader Development, Personnel, Facilities

The Russians Are Coming, The Russians Are Coming§

"Just got to get organized. We've got to get organized."

Jonathan Winters (Officer Norman Jones) to Ben Blue

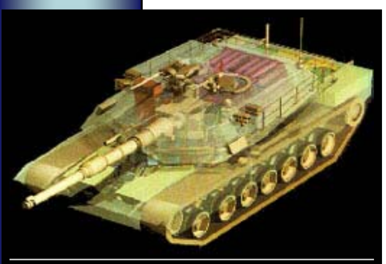
§Metro-Goldwyn-Mayer, Inc., 1966


Decision Making
Where "E" Resides
Knowledge Formation
Sift, Filter, Analyze, Evaluate
Where "T" Resides
Where "M&S" Reside
Information
Requirements
Requirements
Information
Observe, Exercise, Measure, Test
Calculate, Model, Represent, Simulate
Abstraction
Repeated VV&A Process
Abstraction
Single, Unified
Abstraction

The Example:
Ballistic Live Fire Example - 1985

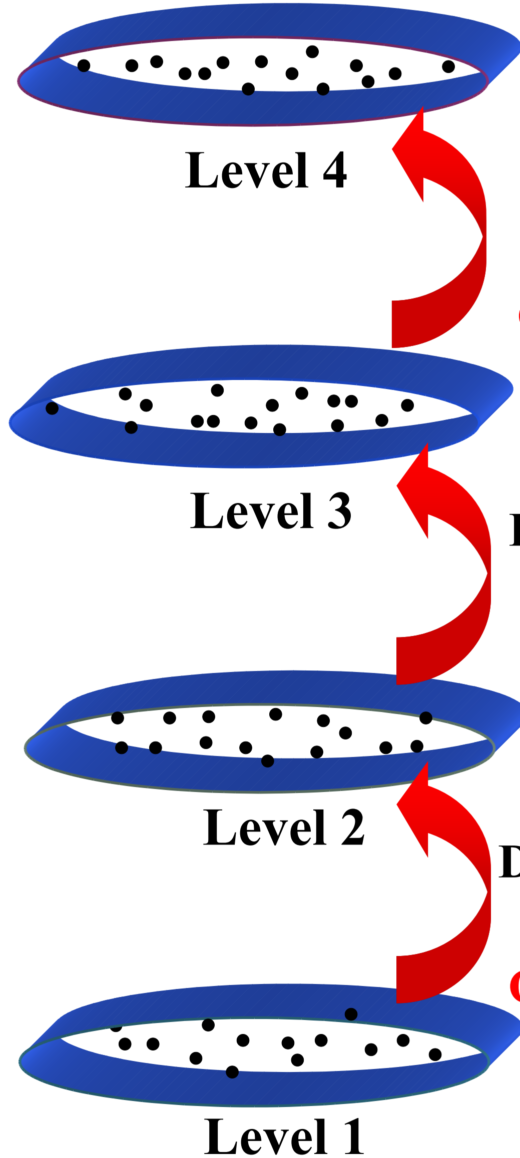
Mission Utility

Functional Capabilities



Post-Event Components

Interaction Conditions



Operational Testing*

$O_{3,4}$ Operator

Developmental Testing*

$O_{2,3}$ Operator

Developmental Testing*

$O_{1,2}$ Operator

* And/Or Modeling & Simulation

Direct Fire Validation‡

Shot	Threat	Perf or Non-Perf	Number of Components Killed	Personnel Casualties	System Evaluation Metrics – Discrete Distribution: M-LoF	F-LoF	K-Kill
1	Threat A	■			Non-Perforation Correctly Predicted		
2	Threat A	■			Non-Perforation Correctly Predicted		
3	Threat A	◆	■	■	■	■	■
4	Threat A	◆	■	■	■	■	■
4*	Threat A	■			Non-Perforation Correctly Predicted		
5	Threat A	■	■	◆	●	◆	■
5*	Threat A	■	●	■	●	◆	■
6	Threat B	■			Non-Perforation Correctly Predicted		
7	Threat B	■			Non-Perforation Correctly Predicted		
8	Threat B	■	■	■	■	◆	■
9	Threat B	◆	■	■	■	■	■
10	Threat C	■	◆	■	■	■	■
10*	Threat C	■	■	■	■	■	■
11	Threat D	■	◆	■	■	■	✖
12	Threat C	■	●	●	✖	✖	■
13	Threat C	■	■	●	✖	●	■
14	Threat E	■	■	■	◆	■	■
15	Threat F	■	■	◆	■	◆	■
16	Threat F	■	■	■	◆	■	■

Perforations
- ■ ≥ 50%
- ◆ ≥ 5% & < 50%
- ● > 0% & < 5 %
- ✖ = 0%

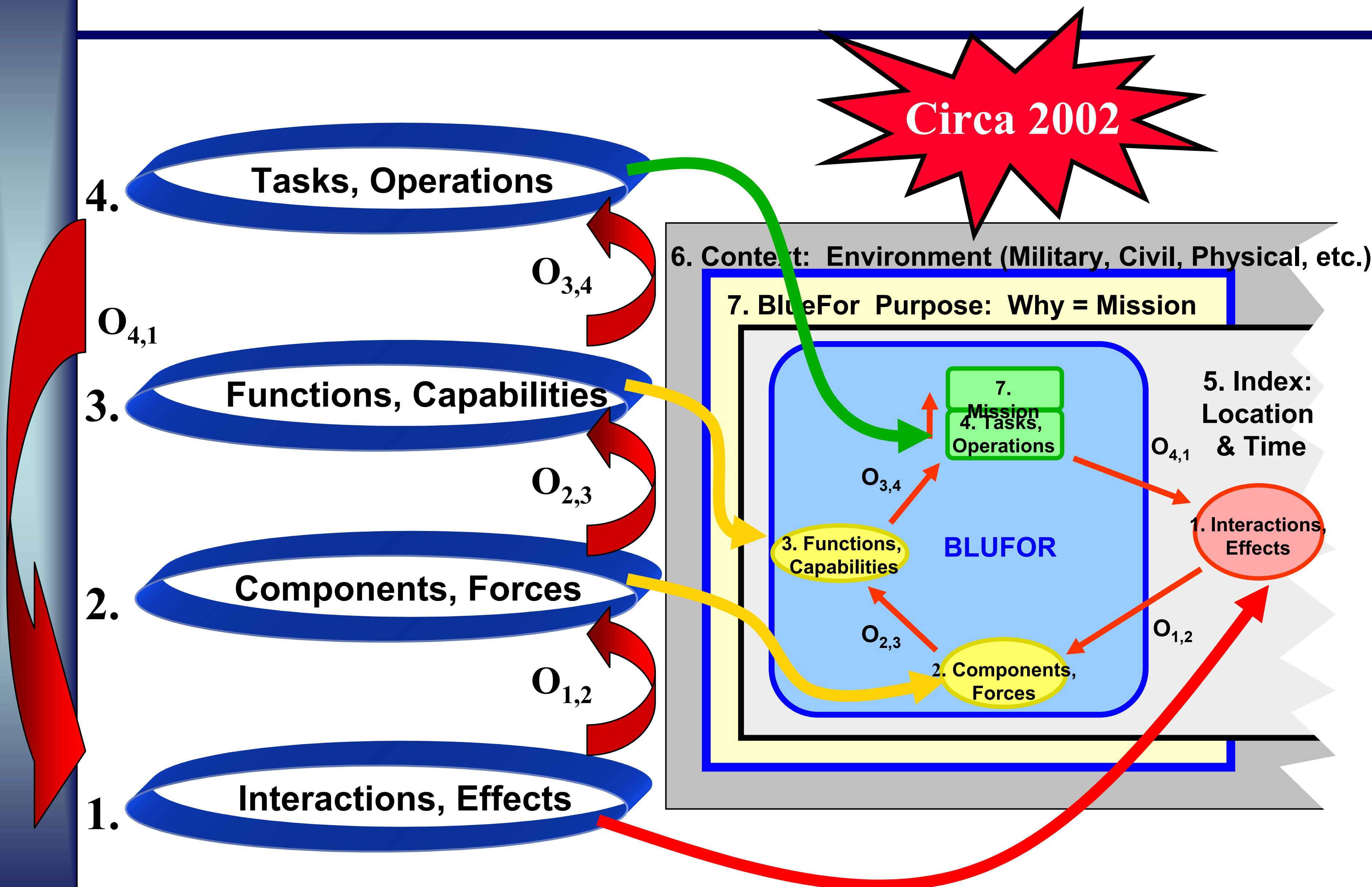
Component Criteria
- ■ ≥ 80%
- ◆ ≥ 50% & < 80%
- ● < 50%

Personnel Criteria
- ■ ≤ 1/2 Crew member
- ◆ > 1/2 & ≤ 1 crew member
- ● > 1 Crew member

Discrete Distribution
- ■ ≥ 50%
- ◆ ≥ 5% & < 50%
- ● > 0% & < 5 %
- ✖ = 0%

‡ From William E. Baker, Richard Saucier, Theodore M. Muehl, and Ricky L. Grote, 1998.

The MMF: Old



Circa 2002
4.
Tasks, Operations
3.
Functions, Capabilities
2.
Components, Forces
1.
Interactions, Effects
O3,4
O2,3
O1,2
O4,1
6. Context: Environment (Military, Civil, Physical, etc.)
7. BlueFor Purpose: Why = Mission
5. Index: Location & Time
7. Mission
4. Tasks, Operations
3. Functions, Capabilities
2. Components, Forces
1. Interactions, Effects
BLUFOR
O3,4
O2,3
O4,1
O1,2

Missions and Means Framework

11 Fundamental Elements: Seven Levels, Four Operators

7. OWNFOR Why = Purpose, Mission

7. OPFOR Why = Purpose, Mission

7. Why, Wherefore, to What End

Missions and Means Framework

11 Fundamental Elements: Seven Levels, Four Operators

6. Context, Environment (Military, Civil, Physical, etc.)

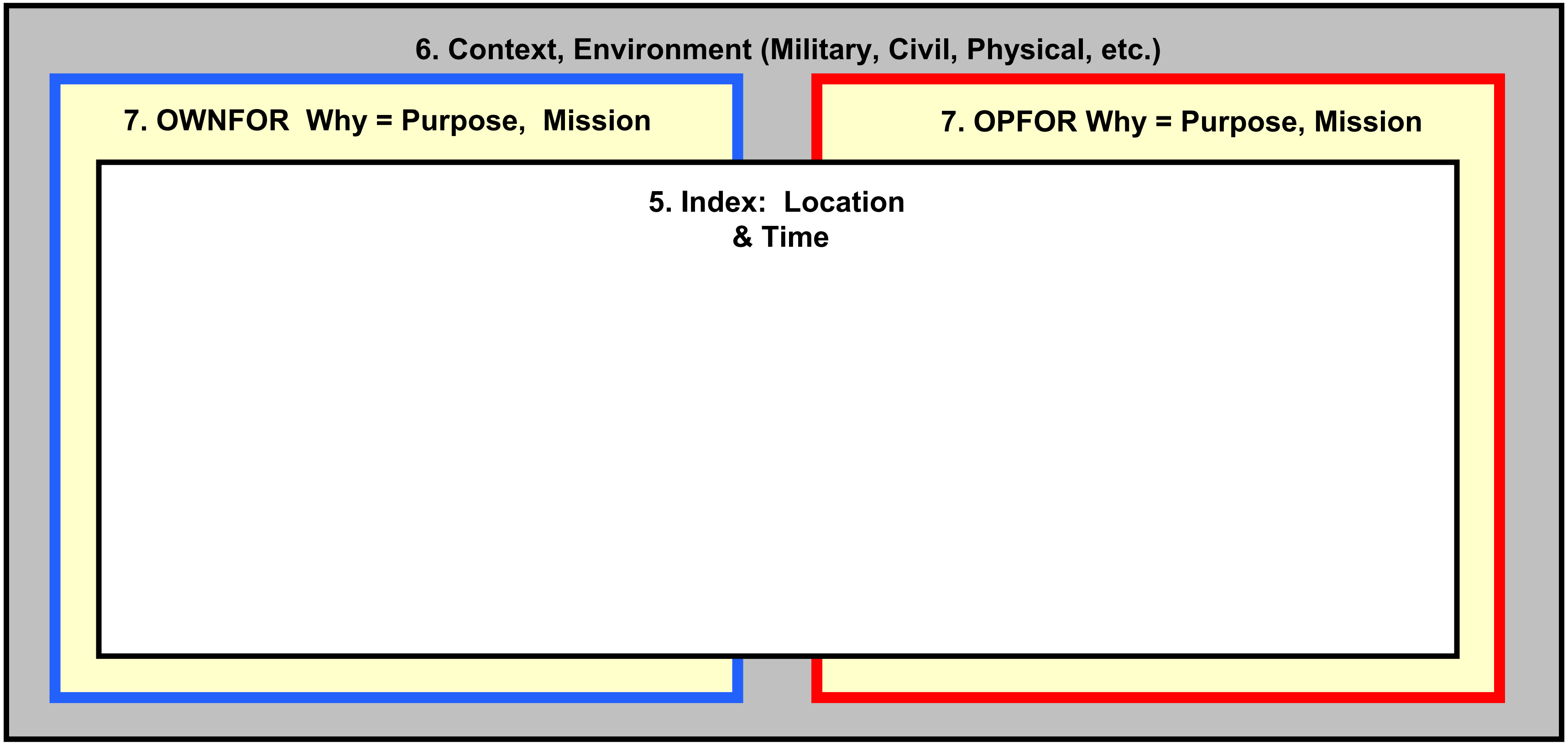
7. OWNFOR Why = Purpose, Mission

7. OPFOR Why = Purpose, Mission

6. Under What Circumstances

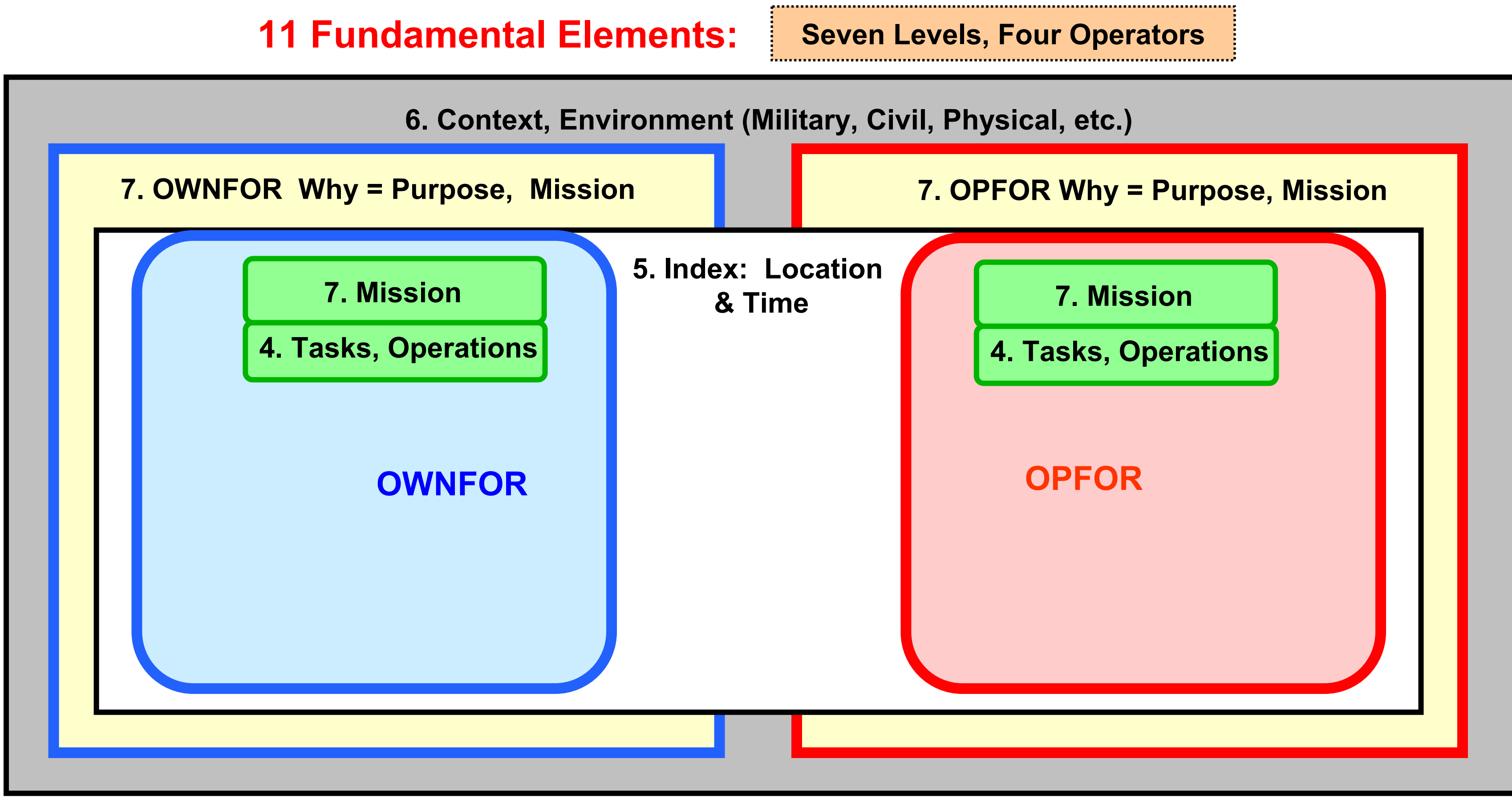
Missions and Means Framework

11 Fundamental Elements: Seven Levels, Four Operators



5. When and Where

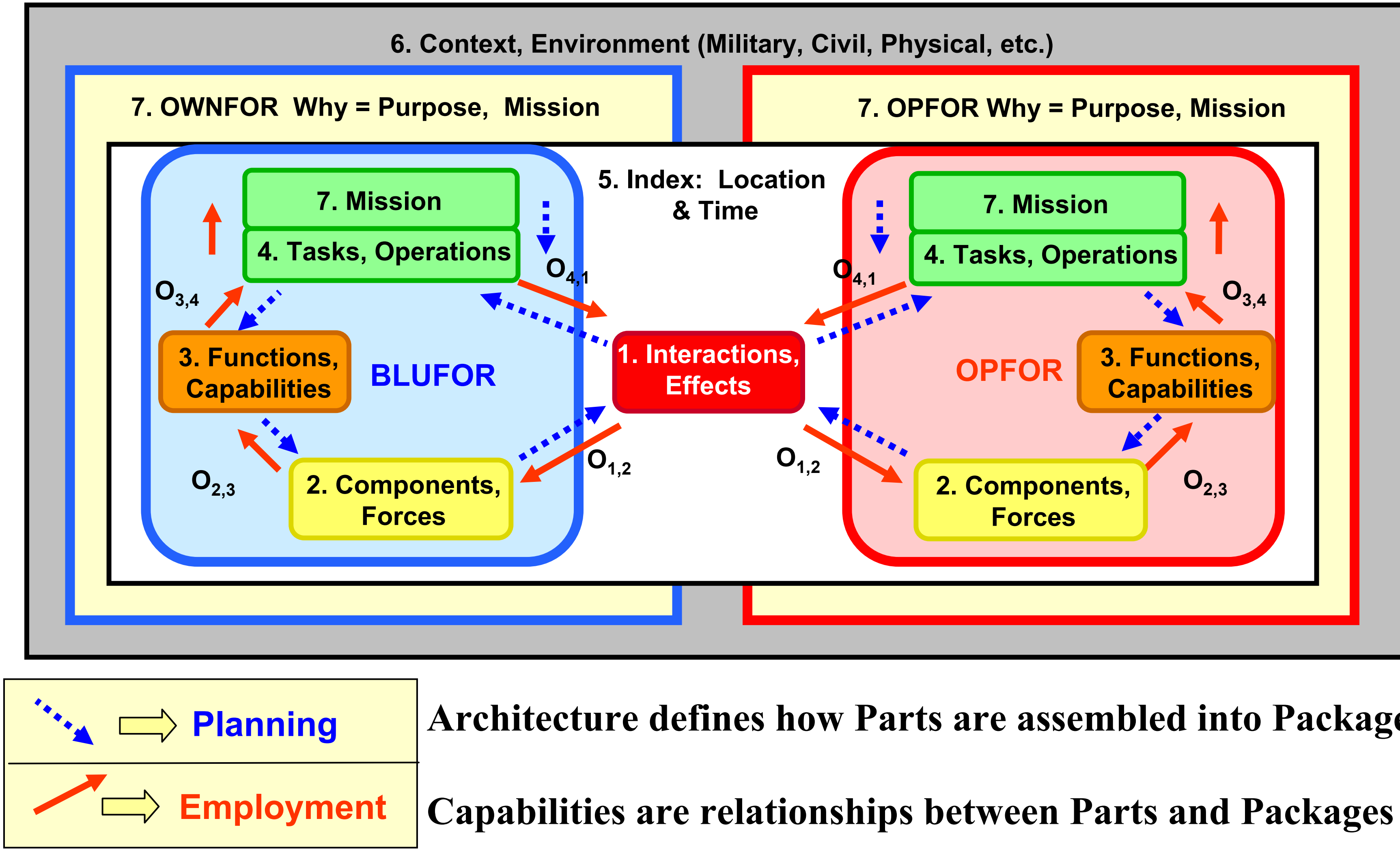
Missions and Means Framework



4. Activity-centric, named with a Verb, "Do What"

"The Playbook"

Missions and Means Framework



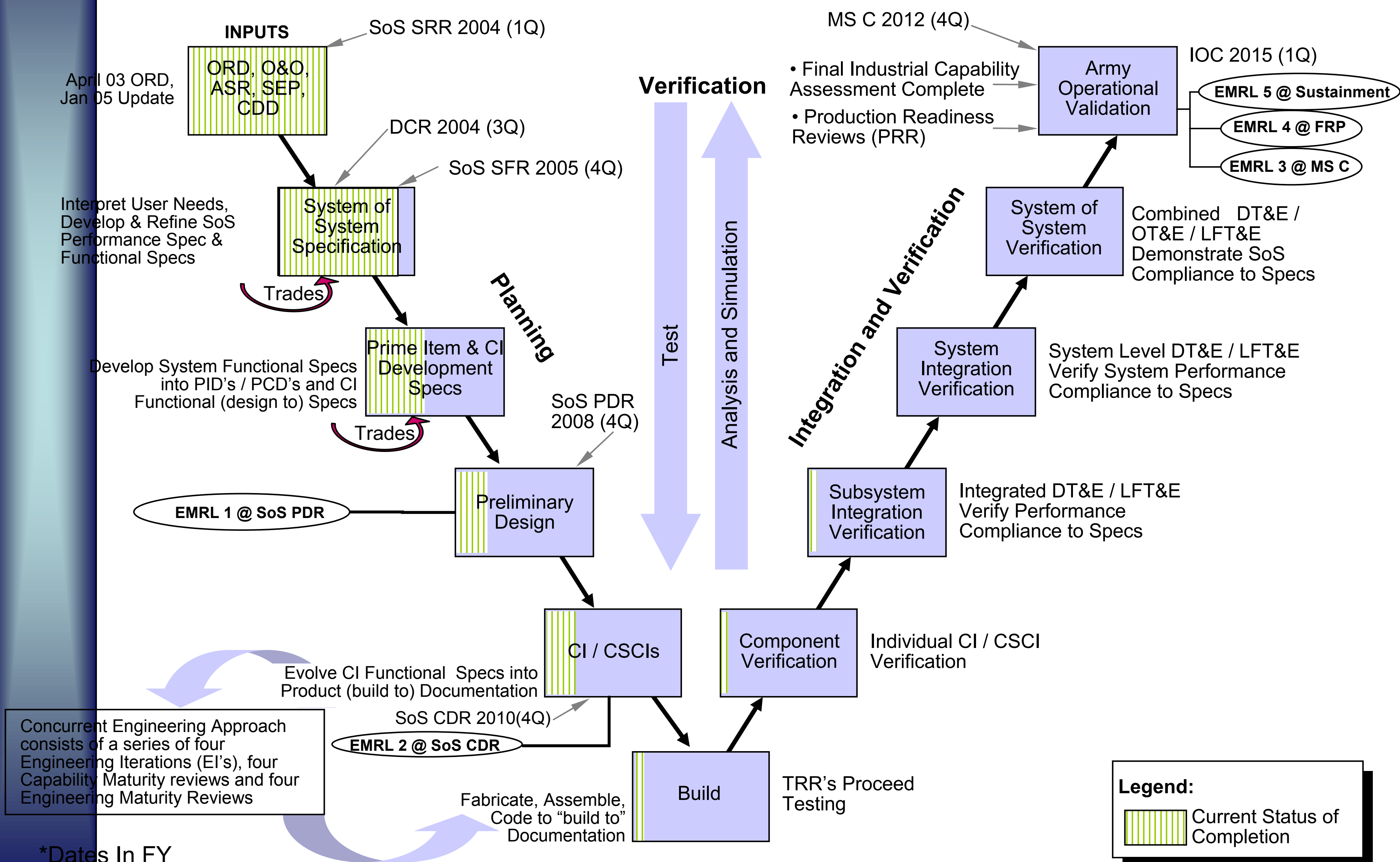
Architecture defines how Parts are assembled into Packages

Capabilities are relationships between Parts and Packages

MMF and FCS

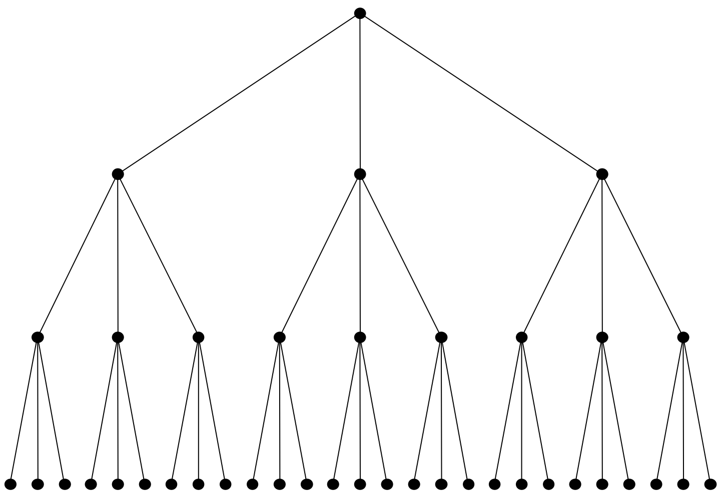
Mr. Jack Sheehan
Chief Engineer, Combined Test Organization
PM UA

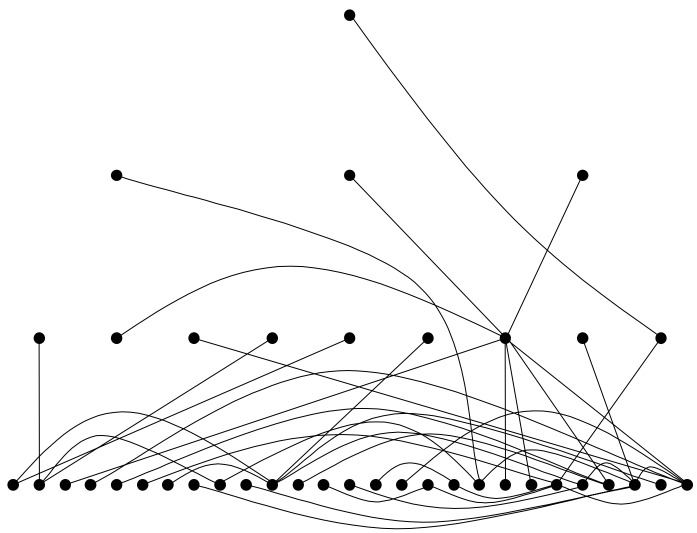
Systems of System Engineering



*Dates In FY

Chains versus Networks





Chain

Too brittle, simple pattern, simple control, scaled

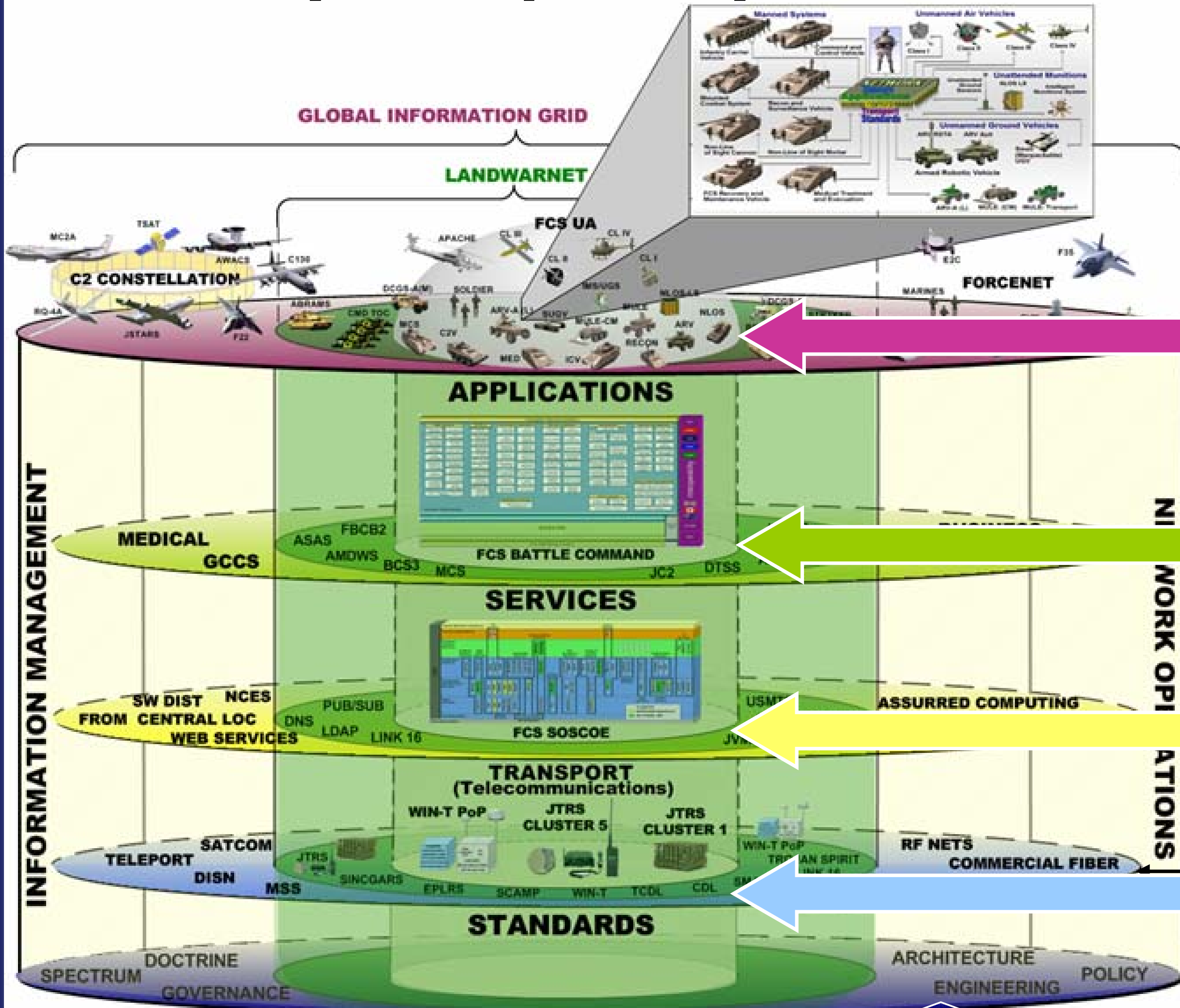
"business end" most poorly connected, hard to reconfigure or change flow

Network

Very robust, complex pattern, complex control, scale free

"business end" best connected, natural to reconfigure or change flow

The FCS BCT Integrates With Army Enterprise System Into the GIG



Integrated Warfighting Platforms: Lethality / Survivability enhanced by underlying network layers
Sensing Systems: motion, visual, audible, etc. ISR: Eyes and Ears of the Commander

BC Applications: assimilate info BC: C2 logic and reasoning based on information

System Services: Common Net-Centric Infrastructure SOSCOE: Tactical Net-Centric Middleware

Transport Systems: networked communications
Networked Communications: comms backbone and omms subnets from GIG to/from ground sensors

Standards: Common Net-Centric technical standards.
Includes DoD guidance, policy, and direction

a-MIND™§ - "Automated Mission Relevant Situational Awareness"

What Is done?

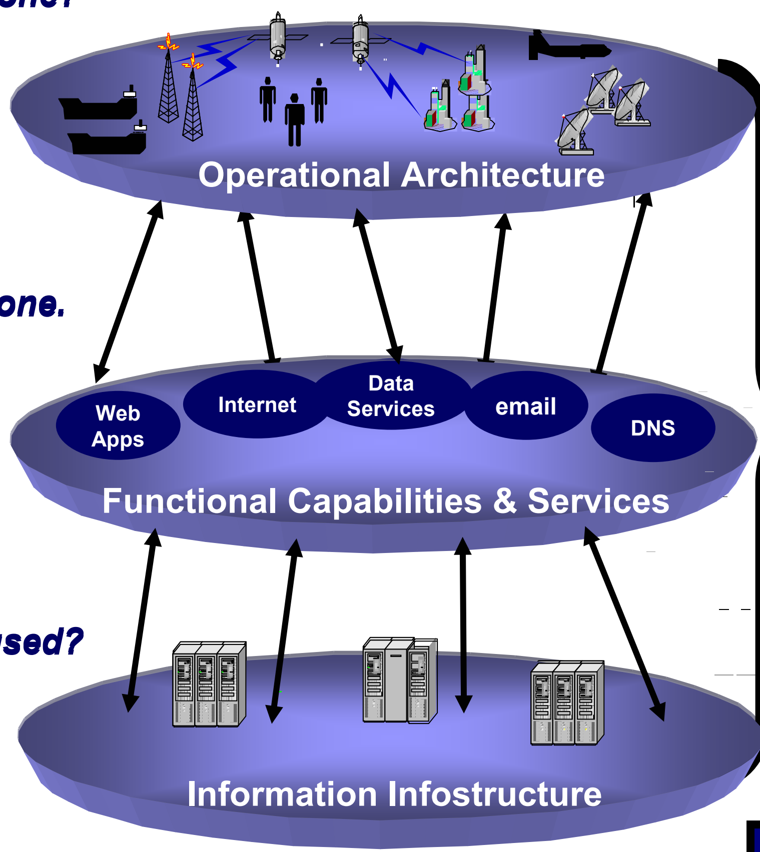
Operational Architecture/Operational Use Case Definition

How It's done.

Operational Use Cases Dependencies on Services Service Layer – Virtual Translator

What Is used?

Infostructure Used to Provide Services

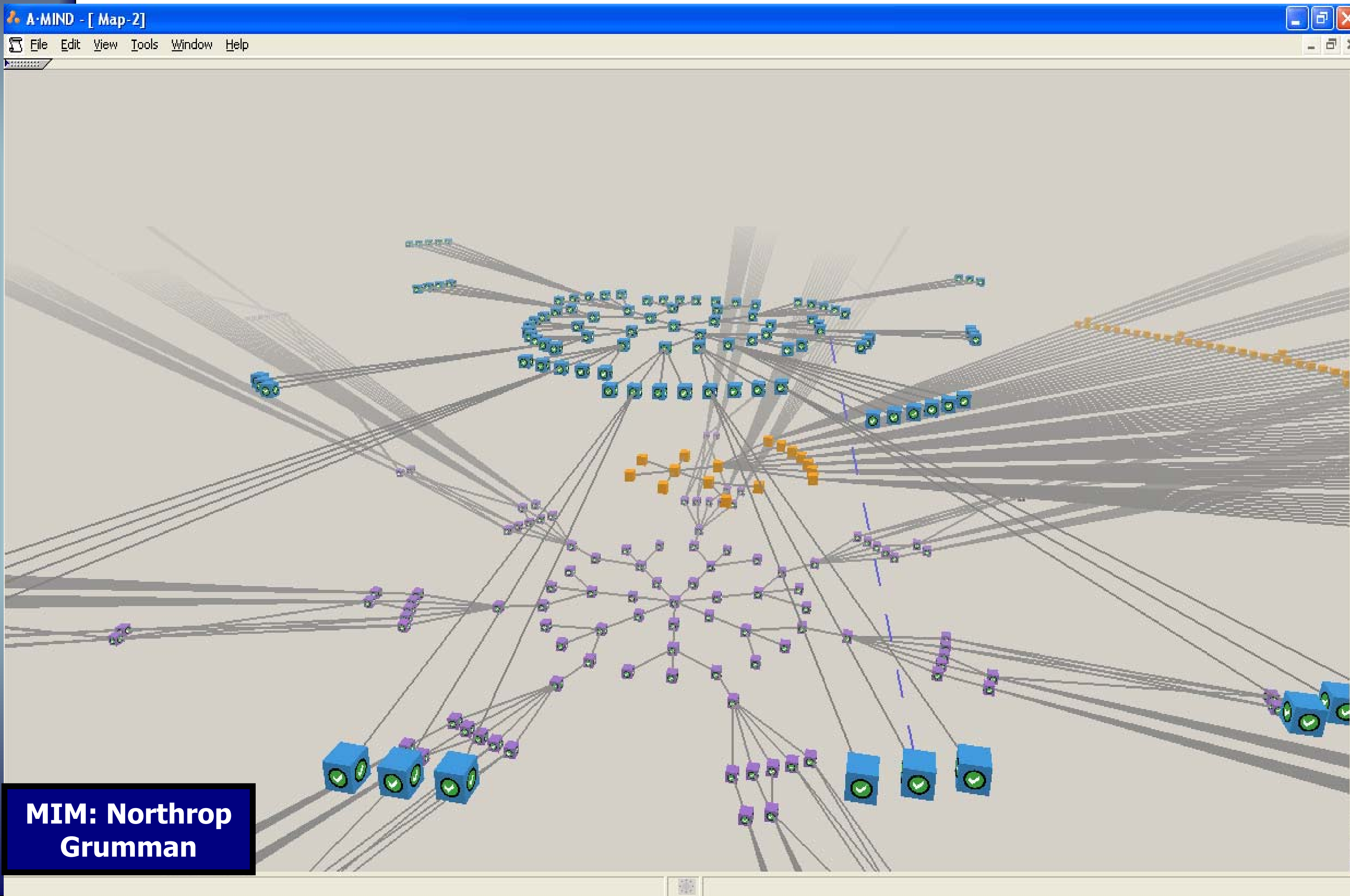


a-MIND Technology automates dependency understanding enabling analysis of Mission Impact of Infostructure Disruptions

- Proven ability to integrate COTS products
- Unique integration and analysis framework – patent filings

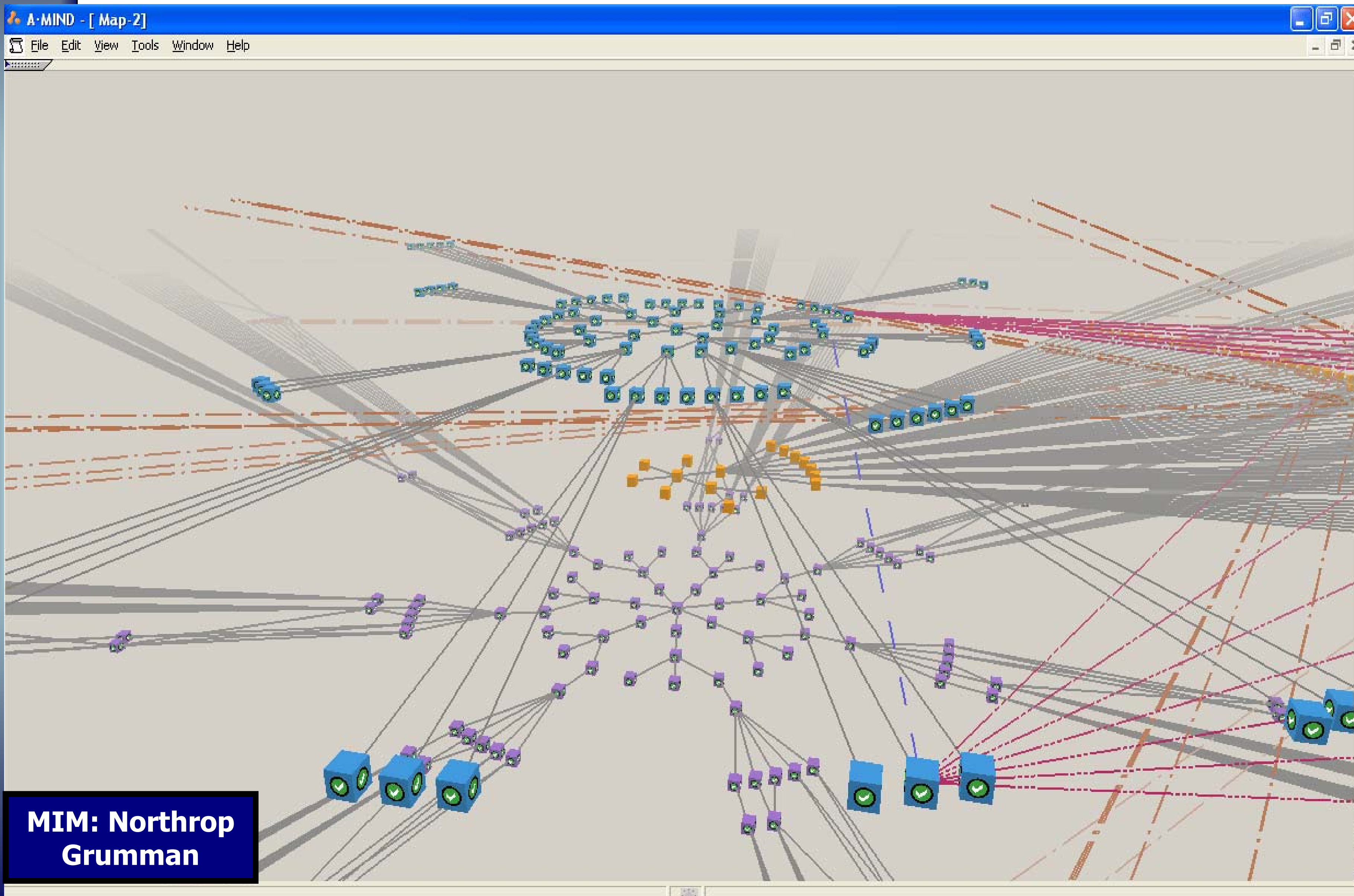
§ Mission Impact Management (MIM) Solution a Product of Northrop Grumman- Patent Pending

Dependencies
Map and view relationships within tiers . . .



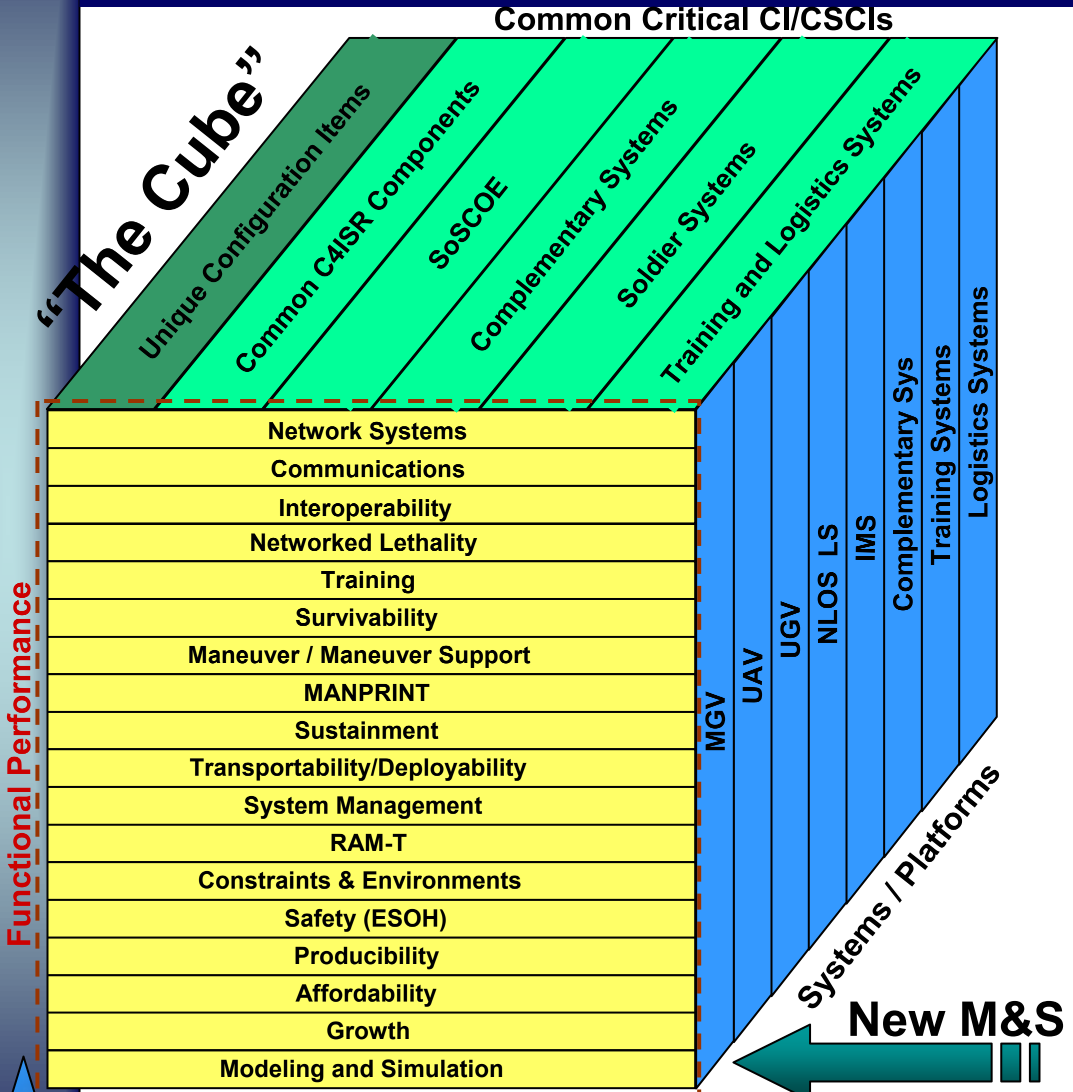
MIM: Northrop Grumman

Dependencies
. . . and between tiers



MIM: Northrop Grumman

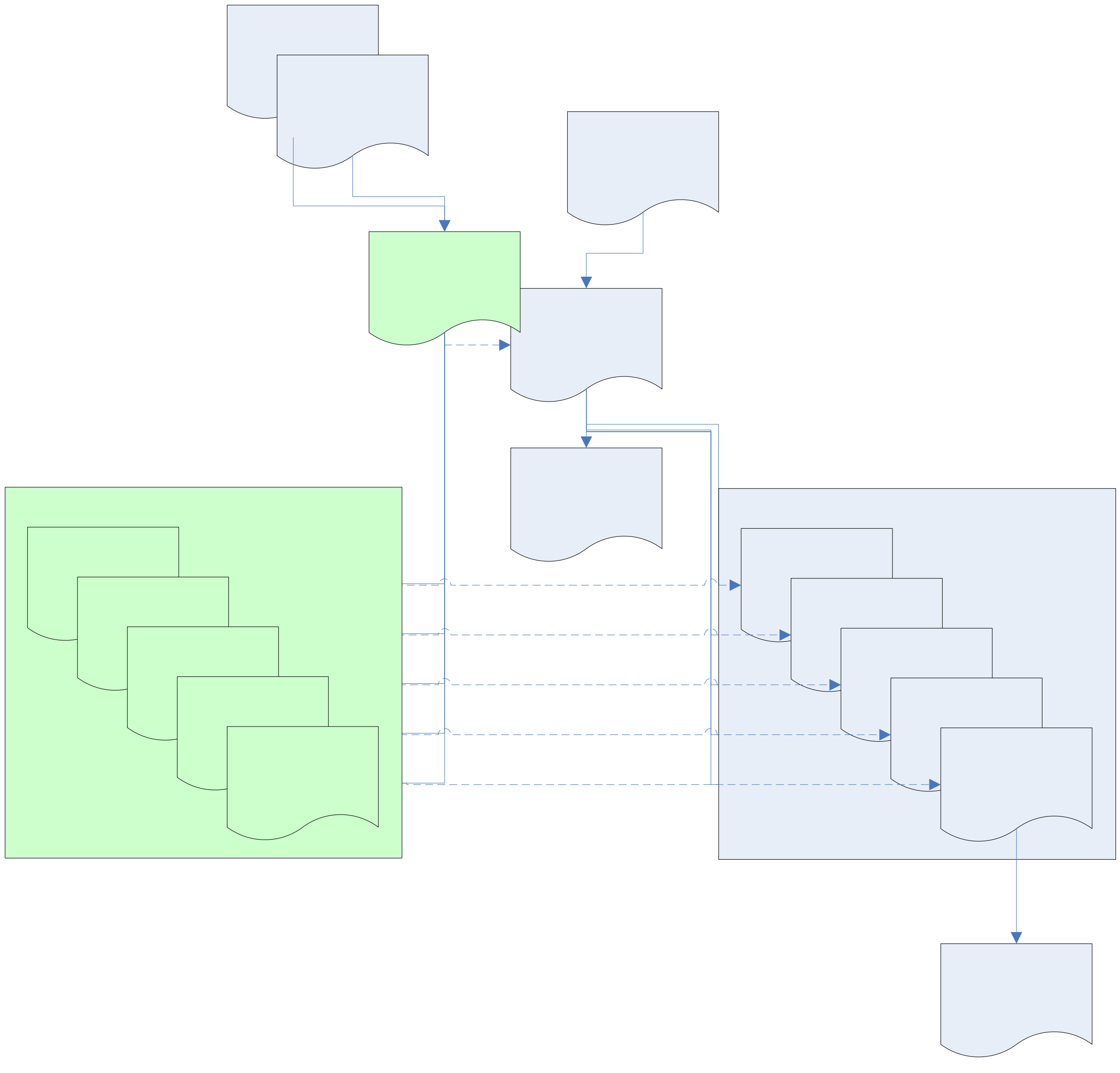
New M&S Requirements Module



- Requirements Modules Established Around the Front-Face of "the Cube"
- M&S Module is intended to enhance the integration and utilization of M&S across all aspects of the program.
- M&S Team is responsible for the application of M&S from "Cradle-to-Grave" and "Top-to-Bottom"

Multi-disciplined Teams including LSI, PM UA & TRADOC

Simple Tree – UGV Example



Panel Summary

Mr. John Illgen
Northrop Grumman Simulation Technologies

Conclusions

- **T&E and M&S have evolved and are managed asynchronously**
  - Adequate evaluation for today's complex SoSs in a Joint context requires extensive complimentary Test/M&S detailed planning and execution
- **Lack of common processes inhibits M&S sharing in the T&E community**
  - No standard "Standard" to assess M&S ability
    - What is a "High Fidelity Model"?
  - No common processes for using/sharing M&S
- **Common understanding through common languages, methods, and processes are crucial to achieving full T&E community integration**

Path Ahead

- **Crawl before Walking**
  - Develop a common understanding of what "Warfighter focused T&E" means to each Service and DoD Agency
  - Develop common language and practices for M&S use in T&E
  - Understand Service/Agency strengths and weaknesses in M&S in a T&E context
- **Community-wide Methods and Processes (M&P)**
  - Standard M&P for T&E across all Services and DoD Agencies
  - Links M&S use within DoD T&E communities
  - Good news: JTEM is making progress in this area

Path Ahead

- **Incorporate MMF as a community-wide T&E Process**
  - Global organizing schema covering both the mission definition and mission execution
  - Common understanding of T&E in Warfighter context
  - Without a global organizing schema covering both the mission definition and mission execution sides of the problem, the many pieces cannot be properly defined, instantiated, linked and executed

The Problem:
How to clarify Lifecycle issues in a T&E context?

Points of Contact

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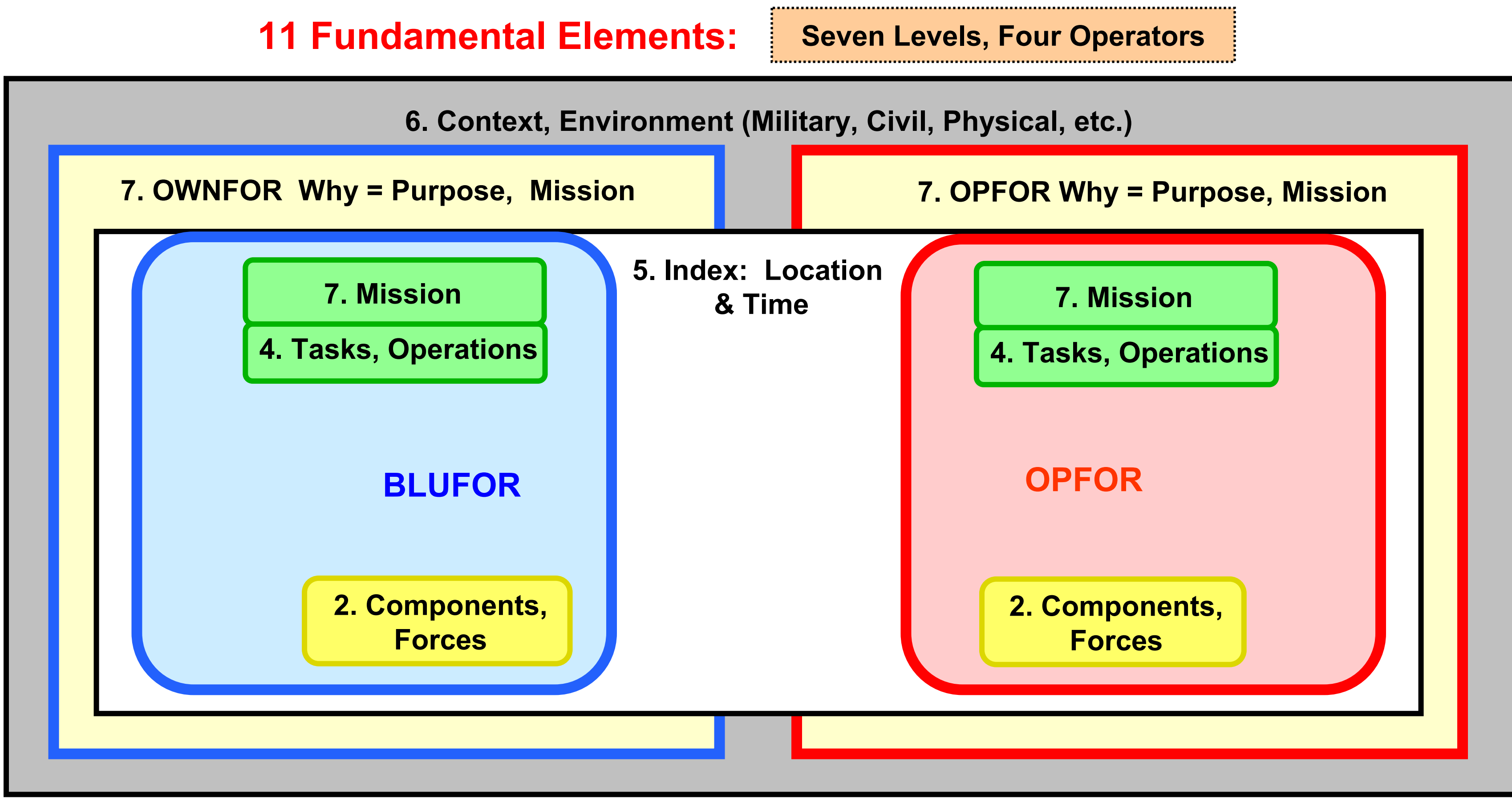
  - Phone: (240) 682-1886
  - augustine.ponturiero@ngc.com

Questions?

Backup Slides

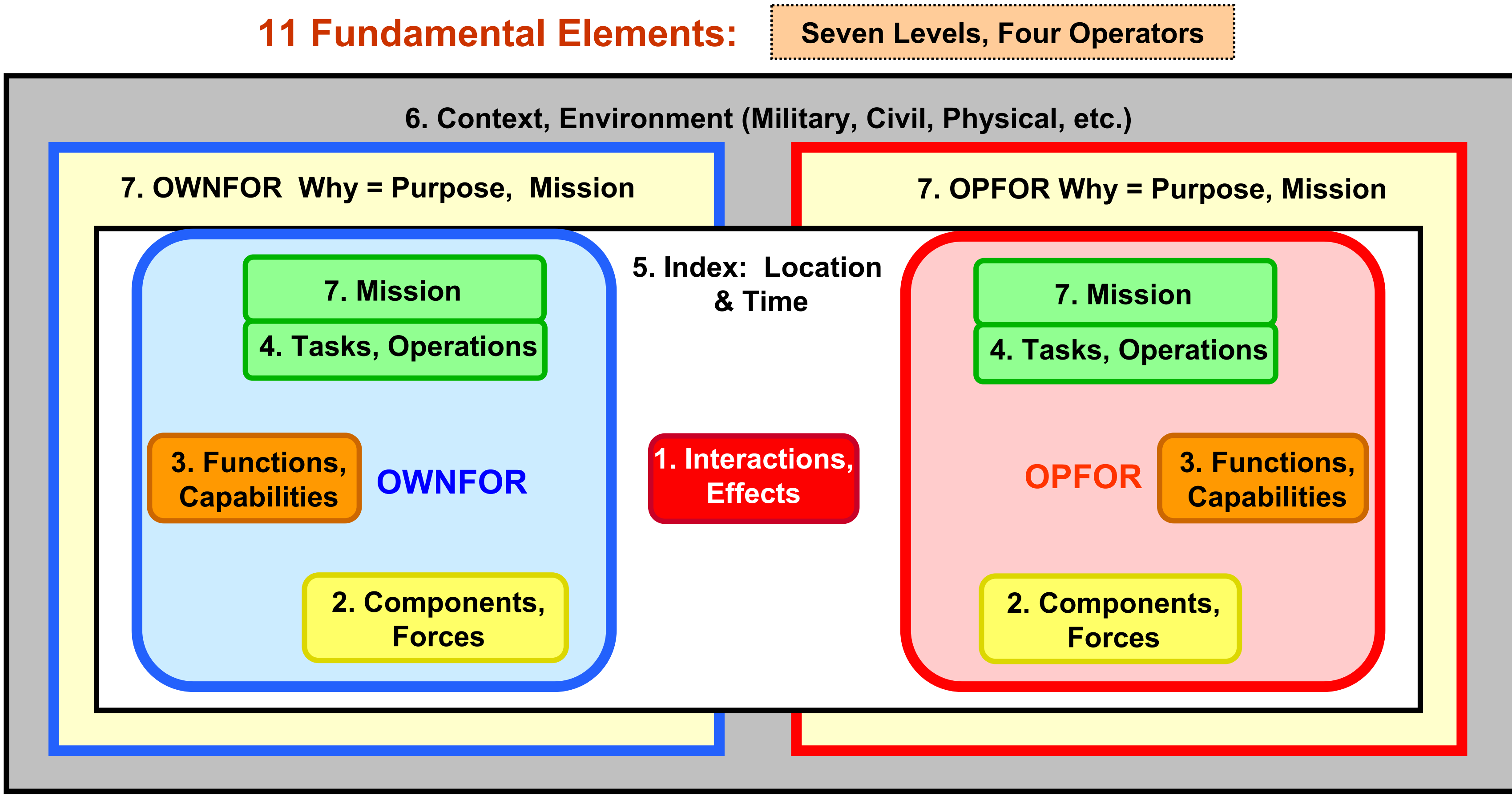
Missions and Means Framework



2. Entity-centric, named with a Noun "By Whom"

"The Players"

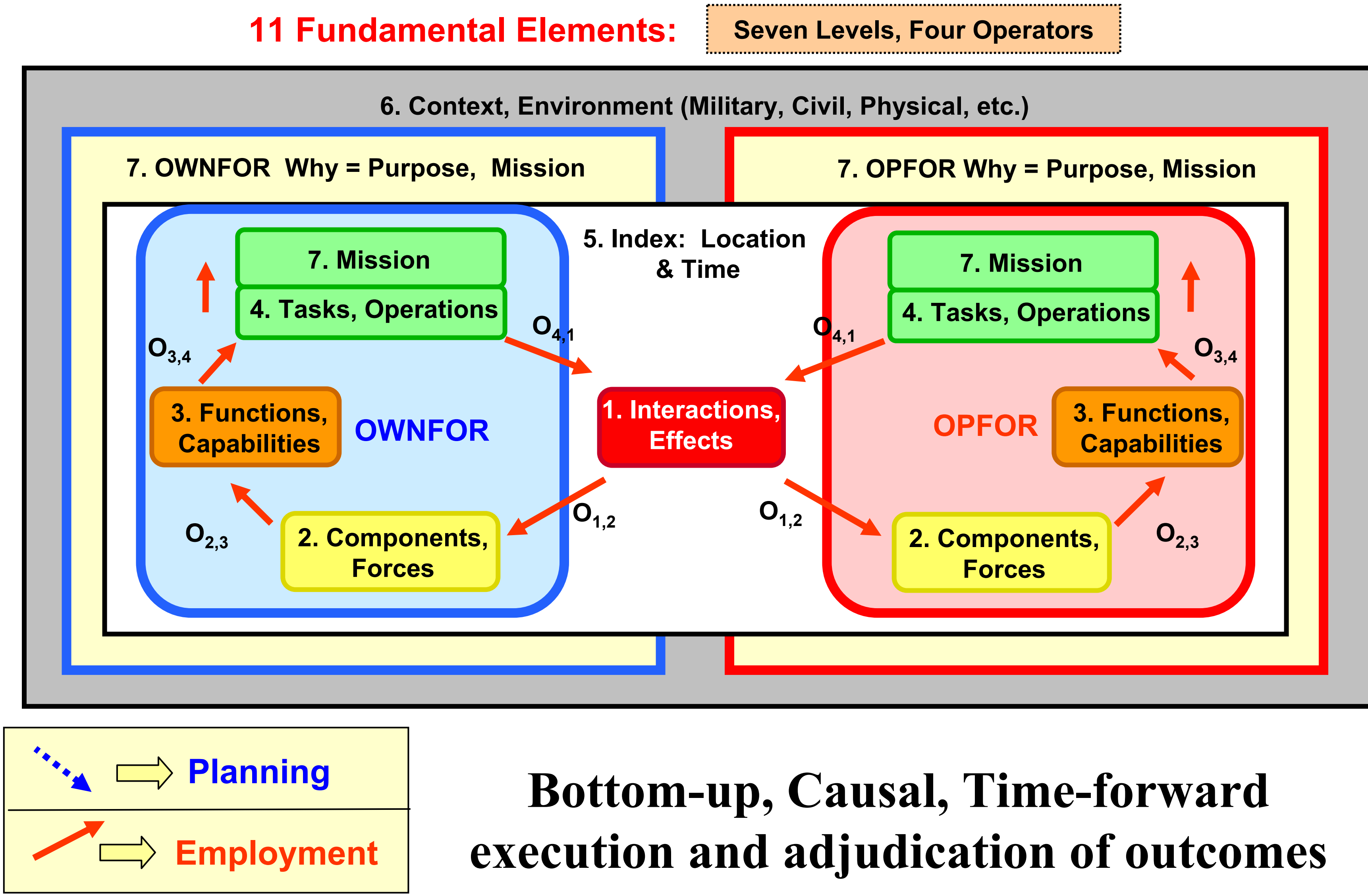
Missions and Means Framework



1. The (shared) Slings-and-Arrows of Outrageous Fortune -- Science

3. Condition-dependent "How Well" -- Engineering

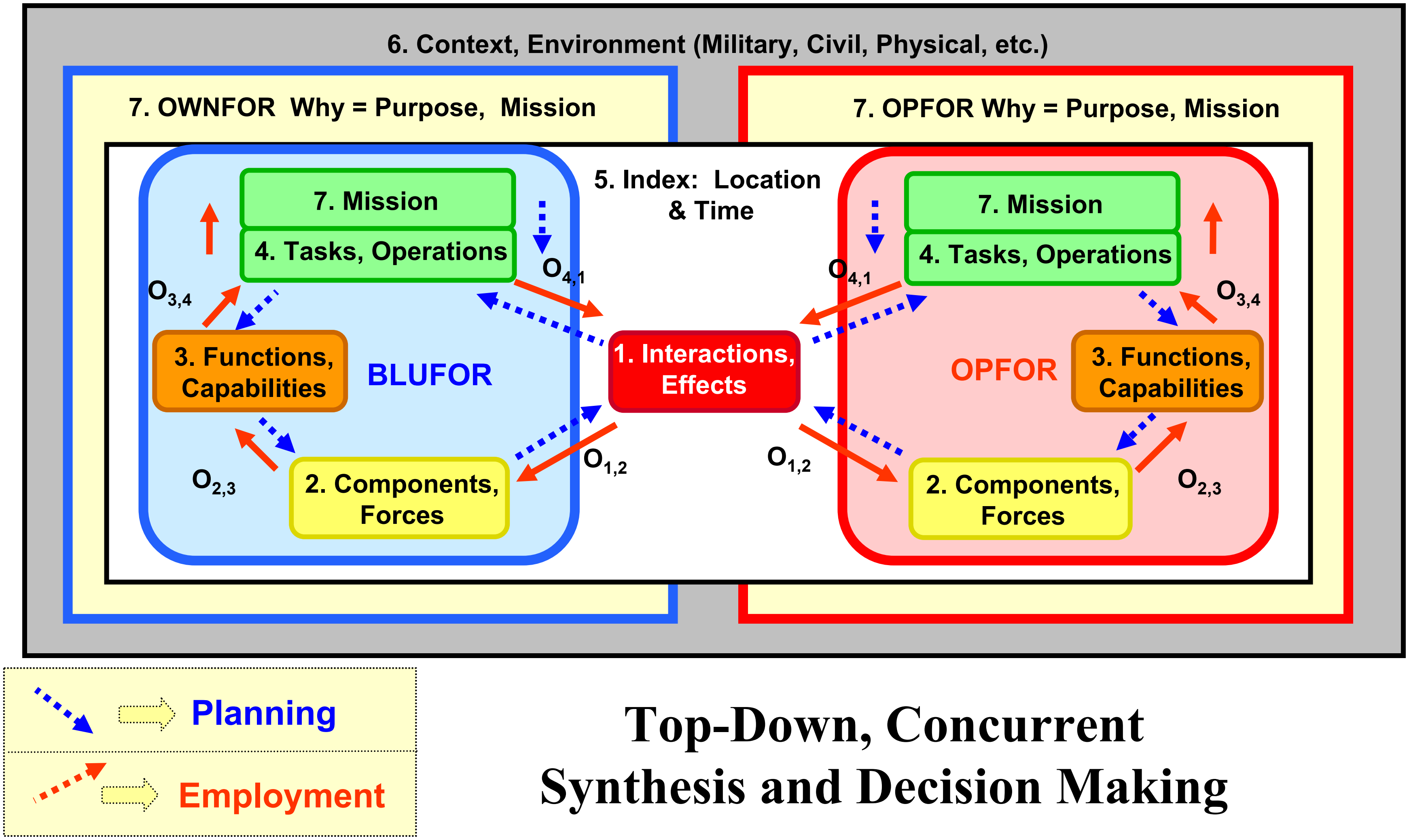
Missions and Means Framework



Bottom-up, Causal, Time-forward execution and adjudication of outcomes

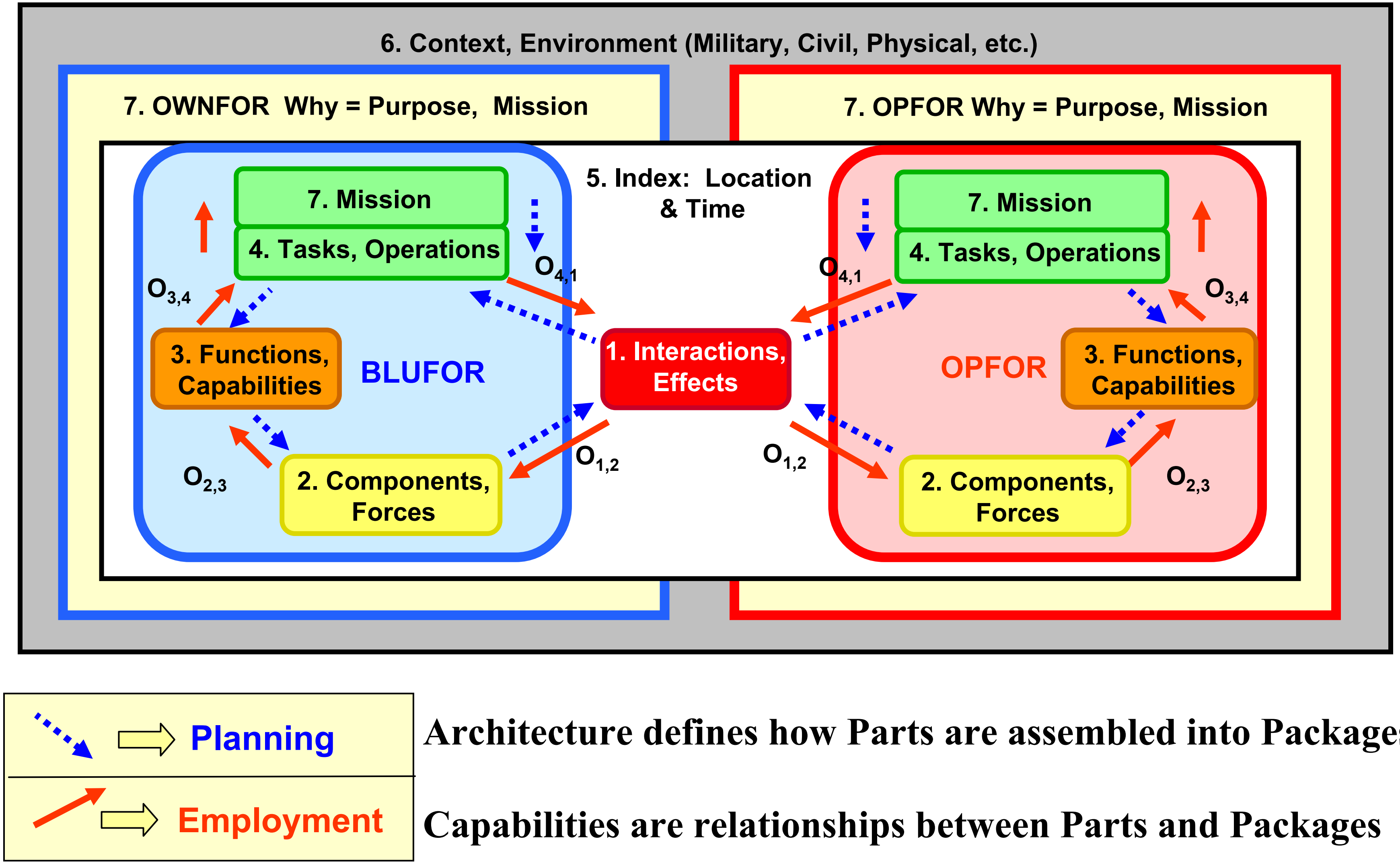
Missions and Means Framework

11 Fundamental Elements: Seven Levels, Four Operators



Top-Down, Concurrent Synthesis and Decision Making

Missions and Means Framework



Architecture defines how Parts are assembled into Packages

Capabilities are relationships between Parts and Packages

Presentation by RADM Charles "Bert" Johnston (USN-Ret), Wyle Labs
NDIA 22nd Annual Test and Evaluation Conference
Jacksonville, FL
March 8, 2006

Good afternoon. Like many of you, for years I've followed the advances of modeling and simulation and listened to promises of cost savings and better, faster, more efficient testing. And I've always been a huge fan of M&S, but the reality didn't always live up to the promise. In the early days the M&S folks would say, "We are 10 – 15 times cheaper than open air testing." But when you added in the cost of the simulation facilities, the cost to develop the simulations, and the cost of open air testing just to validate the simulation, it was sometimes hard to find any savings at all.

And later as our systems got more complicated the M&S folks would say "You need us now for repeatability and accuracy and speed, and to help you determine where to look during open air testing, and to do all the software 'what if's', and we are 10 to 15 times cheaper." All true but not compelling because when it came down to it, there was usually some glitch or issue that affected the accuracy of the simulation. So, like many of you, I've been disappointed when the reality didn't live up to the hype. A retired Admiral friend of mine once compared M&S to the economy of Brazil – it has wonderful potential, and always will have!

As a result, M&S has been the step-child of RDT&E. And while there have been some great success stories, what we remember most are the stories of mistakes and foibles. One of my favorites involves our allies the Aussies, who I had the pleasure to work with in Melbourne from 1989 – 1992.

As virtual reality simulators assumed larger roles in combat training, programmers went to great lengths to increase the realism of their scenarios, including detailed landscapes and--in the case of the Australian Northern Territory – they included herds of kangaroos and then modeled the local marsupials' movements and their reactions to low flying helicopters (since disturbed animals might well give away a helicopter's position).

Being efficient programmers, they just re-appropriated some code originally used to model infantry detachment reactions under the same stimuli, changed the mapped icon from a soldier to a kangaroo, and increased the figures' speed of movement.

Eager to demonstrate their simulator for some visitors, the hotshot Aussies "buzzed" the virtual kangaroos in low flight. The kangaroos scattered, as predicted, and the visitors nodded appreciatively... then did a double-take as the kangaroos reappeared from behind a hill and launched a barrage of Stinger missiles at the helicopter.

And, in fact, our M&S and software folks have been the brunt of several great jokes. My personal favorite is the one about the

Program Manager, chief engineer, head of logistics, and M&S lead who are riding together in a car that has suddenly lost its breaks and is careening down a mountain road. Fortunately, the road followed an old logging trail with several “runaway trunk ramps” built in. Just when it looks hopeless, the Program Manager, who is driving, sees one of the old runaway truck ramps and steers into it to stop the car. The PMA immediately says, "I want a tiger team to investigate this incident, want a POA&M to address our recovery plan, we need funding established and all POCs indentified." The Chief Engineer says," I want to field strip these brakes, do an non-destructive investigation, stress analysis and fault tree analysis and get the brakes back in service by tonight! The Chief Logistition says, “I want to see which parts are non RFI, do an RCM analysis on the brakes, and have the new parts ready to install by early this afternoon. The M&S lead says, "Hmmm, I didn’t see this in the simulation, let's push the car back up to the top of the mountain and see if it does it again!"

Well I think we did ourselves a disservice by pinning the benefits of m&s on speed, accuracy, repeatability and cost savings. Yes, these are important; but if this is your only rationale, you face the value issue -- while the cost might be less, the product is worth less. As all of us who have been involved in test know, there is no substitute for open air testing.

But in the last few years, we’ve seen a growing tolerance for M&S. There are places where “open air testing” doesn’t want to go or can’t

easily go and is begrudgingly happy to have M&S around to help. Where might some of those places be?

First, dangerous tests – live fire testing might count here -- where the test article and the projectile are real but the environment is simulated. But if you don't want to count that as a true simulation, how about testing warning systems -- like aircraft ground proximity warning systems, or collision avoidance systems where you want to point the aircraft at the ground or another aircraft and see if the automatic warning comes on just in time to avoid disaster.

Second, there are tests where security could be compromised if done in open air such as testing an emitter at a new frequency, of testing the war modes of a system, or trying new tactics during OT that spying eyes might see.

Third, there are tests where it's impractical to do open air testing – jamming in open air – we once knocked out all the TV's on the east coast testing a new EA-6B jamming pod; or because of the density of the threat environment can't be replicated at one of our electronic ranges. We did the V-22 Operational Assessment on threat detection capability and response in the Air Combat Environment Test and Evaluation Facility at Pax River. By the way, it was critical to that test was that the Operational Testers had certified that for the purposes of the test, the facility was operational representative.

And finally there are tests that are just too big to routinely be done with open air testing. As our systems get more complicated and integrated together, it's hard to coordinate live assets for test so we let M&S go first to work out any kinks. Testing MIDs (Multi-Functional Information Distribution System) which is a new system for sharing data-link and voice in the battle field, required numerous ships and aircraft operating together to test the ability of the system to provide a flow of information. The first time we tested MIDs on a large scale was in simulation to ensure we had the systems working OK before tying up a large number of real battle group assets. And sometimes the new systems or the systems with which our system under test must interface are also in development and aren't yet available and we have no choice but to use modeling and simulation.

As our systems get more complex, we can expect that we'll need M&S more and more in the future. And our systems will get more complex. There is a saying, "As long as all things are created from scratch, growth can at most be linear". We're too clever to create things from scratch so you can expect that we will continue to use a building block approach. Accordingly the complexity of our systems will continue to increase non-linearly and modeling and simulations will become more and more important to prove that they are interoperable.

In fact, in June 2003, DoD put out a memo that declared their intention to test for interoperability over the life of the system.

So I think all of us involved in research, development, test, and evaluation believe that M&S finally has a seat on the bus. It may not be a window seat, but it's a seat. For RDT&E, M&S is tolerated, thank you very much.

In fact, if M&S was represented by a character in a movie, it would be the hapless city slicker in a Western -- trying to start a new life in the rough and tumble prairie. I can imagine a scenario where the tenderfoot is proudly standing on the front porch of his newly purchased ranch house, wearing his brand-new cowboy boots, surveying his vast holding. He is approached by a rough and tumble cowboy who represents "Open Air Testing". The cowboy says to the tenderfoot. "Welcome neighbor. I live about 5 miles down the road. I want to have a little get together tonight to welcome you to the territory."

"Oh, that would be great" says the Tenderfoot.

"Yeah" says the old cowboy, come on over about sunset, we'll do some eating and drinking." "some fiddling and some dancing" "probably be some shooting" "definitely be some fighting" "but they'll be some loving, too".

"Who all is coming?" asks the Tenderfoot

"Oh, just the two of us." Says the cowboy

As our ability to accurately model systems increases, and as the memory and processing power of our computers increases, it's natural that our RDT&E infrastructure would support new areas in the life-cycle of our systems. Two of these – demonstration and experimentation -- are at the beginning of a system's life, and two of these – training and rehearsal – are later in the system's life. The infrastructure built to support research, development, test and evaluation – the open air ranges, software support activities, hardware in the loop facilities and our facilities that create synthetic environments – is becoming host to rehearsal, demonstration, training, and experimentation – or the new RDT&E.

In fact, some months 10% of the events we support with our infrastructure are either rehearsals, demonstrations, training evolutions, or experimentation -- and it is growing. In the manned flight section of ACETEF, this percentage has grown from 50% to 80% in the last few years. Nearly every test flight is rehearsed in the ACETEF before it's flown. And in this new RDT&E, modeling and simulation doesn't just have a seat on the bus, it is driving the bus.

In our business, if you want to know what's important and what folks are willing to support, you follow the money. Joint Forces Command is competing a five year program starting in Sep to support USJFCOM's Joint Trainer responsibilities for planning and conducting

exercises, crisis rehearsals and other training events from inception through execution.

The long-term mission of this initiative is to incorporate service branches, interagency and multinational coalition partners. By 2009, the goal is to have the capability to train any audience in joint warfighting – whether it be a unified command staff, one of the services, or multinational and interagency personnel. The persistent network will focus on joint training, experimentation, testing, education and mission rehearsal, by linking command and control, training facilities, and ranges and simulation centers throughout the world.

Meanwhile DoD is creating the Joint Mission Environment Test Capability to provide testers and developers a robust nation-wide distributed engineering capability, by integrating live-virtual-constructive simulations with systems under test, giving the Department the capability to "Test like we fight." DoD wants to ensure interoperability between JMETC and JNTC, and is developing the JMETC to support the JNTC.

Here's what's interesting to me. A member of the new RDT&E – in this case training – is setting the standard for traditional RDT&E – in this case testing. We're likely to see more of this in the future.

And oh yes, M&S does save money in the new RDT&E -- especially with training. Real, measurable, auditable, money. All the services

have accepted simulation as a replacement for flight time – not just an augmenter for flight time. So have our allies – at the French Army Aviation Training Centre 30% of the training is performed in simulators and procedural trainers. There are lots of examples from the commercial side. Most new airline pilots do 100% of their training in simulators – the first actual flight is with passengers!

Very light jets are preparing to make their debut this year. The Eclipse 500 is tentatively scheduled for FAA approval this month. These jets cost under $3M each and are powered by 2000 lb thrust engines and weigh less than 12,500 lbs. Now you can always get insurance, especially since many of the inexperienced folks who can afford these personal jets can afford the insurance. But the key to getting affordable insurance, according to the under-writers, will be to participate in a highly focused and type-specific training program with significant simulation. A private pilot with a multi-engine rating and just 500 hrs total time who completes the manufacturers training program would pay about the same amount for insurance as a commercial pilot with 2500 hours and 500 hours of multi-engine time would pay.

A growing use of simulators is in a field related to training – mission rehearsal. Complicated missions are being flown in rehearsal before being flown for real. Simulation shows the pilot the expected outside environment (visual, radar and FLIR), the expected defensive threat laydown, and allows for rehearsal of the weapons employment.

SOCOM is developing a Common Environment/Common Database which will be integrated into the simulators for the US Army Special Operations Regiment. They have compiled a wide range of imagery, navigation, communications and radar data into a centralized database. Members of the Regiment are able to create customized simulation of the actual combat zone where they will be deploying an do it in hours, not months. One of the main reasons for the development is to shorten the mission rehearsal timeline. Now several of the other COCOMs are asking for simulators in theater – not only for training but for rehearsal as well.

All the services are investigating how game simulation can replicate real operations to help train warfighters. Everyone realizes that gaming isn't a valid substitute for real-world military training and live-fire drills, but gaming is being investigated as accepted as an alternate training method. The industry believes that videogame technology can fulfill many training needs at a much lower cost that traditional large-scale simulations. By the way, that may be the first time many of us have heard the words "traditional" and "simulation" used together.

The Navy is investigating whether a video game that replicates operations aboard an aircraft carrier can help train ship and aviation flight deck personnel. "24Blue" was modeled upon flight deck operations on the aircraft carrier USS Harry S. Truman. The objective of the game is to launch a sequence of fixed-wing aircraft—including the F-18 Hornet, the EA-6B Prowler and the S-3B Viking—off the ship before it's attacked.

Not sure about gaming? You think the folks who built games aren't interested in DoD as a customer? Consider this: game development studios are the closest thing we have to steady simulation talent – and Ben Sawyer a gaming expert and founder of the "Serious Games Summit" which was held in Arlington, VA in 2005, claims that most successful gaming firms are hybrid studios that do gaming and "serious gaming". Many believe that the importance of gaming will continue to grow, and although it has taken over the role of step-child from M&S, will one day it will have a role as important as M&S does today.

So while M&S is clearly supporting training and rehearsals, what's it doing for demonstration and experimentation? Keep you eye on this! Clearly M&S will have a huge role as we look at the "art of the possible" and develop new tactics for systems before they are even developed. M&S has been involved in past experiments, but it's been awkward. The folks responsible for the experiments didn't have funds to pay for the participation of new systems and had to have program managers and others offer their support. Today, the value of experiments is clear and money is being made available to the experiment leads to pay for the systems they believe are needed.

So what is the future? I believe the new RDT&E will drive M&S in the future. And while there are several 600 lb gorillas in DoD that will define M&S interface standards (JSF, FCS, JTRS) most of the standards for M&S will come from self-forming groups of interested

folks who reach agreement on where we need to go. And this group better include our contractor teammates.

So the future for M&S is pretty good. Now, let's go back to our tenderfoot standing on his porch and the grizzled cowboy that was having a little fun at the his expense. As the cowboy starts to leave he says with a grin, "See you tonight, pardner. And, oh by the way, my name's Tex. What's your's?" "Wayne" says the stranger, "John Wayne." Yes the future will be very interesting indeed. Thank you.

Air Force Flight Test Center

We conduct and support the research, development, test and evaluation of aerospace systems from concept to combat

U.S. AIR FORCE

AD INEXPLORATA

Making DT&E and Modeling & Simulation Better Partners

Dr. George Kailiwai III
AFFTC Technical Advisor
7 Mar 06

We are THE path to success for delivering warfighting capabilities

Overview

- Background
  - Need for “Teaming”
- Natural Tensions
- What Can Be Done to Team Together
- Examples of AFFTC Teaming
- Recommendations

Background

- Role of DT&E—independent verification
  - Does system do what it was designed to do?
- Role of OT&E—independent validation
  - Does system do what it is supposed to do?
- Role of M&S in DT&E
  - Initial design
  - Refine design
  - Test design when conventional means impractical/not feasible
- Role of M&S in OT&E
  - Test system when conventional means impractical/not feasible

Natural Tensions Between DT&E and M&S Communities

- DT&E may feel threatened by M&S
  - Less Testing → Less DT Work → Less Job Security
- PM may feel DT&E too expensive…takes too long
- M&S says, "We can do it all!!"

Possible Implication:
PM question value of DT&E and be motivated to perform testing via M&S only

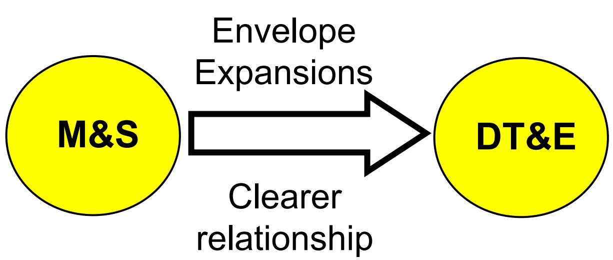
- Global Hawk

WRONG APPROACH

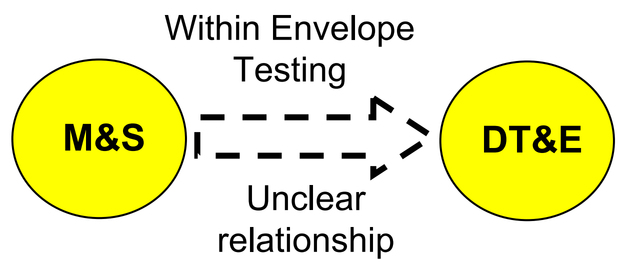
Current DT&E/M&S Interaction

DT&E/M&S Independent Relationship

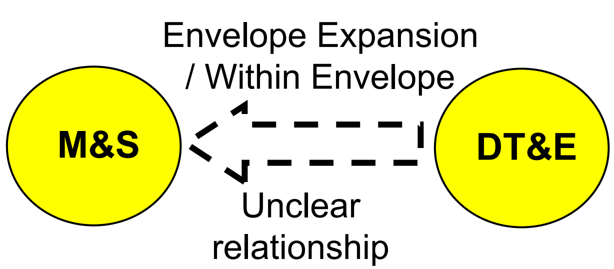
High Risk Tests



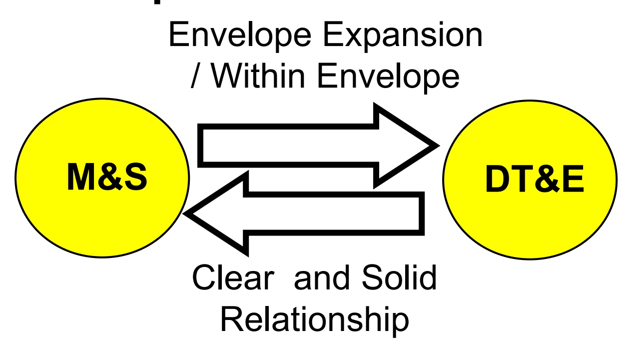
Routine Tests



High Risk & Routine Tests



Preferred Relationship



From Mutual Exclusiveness to Interdependency

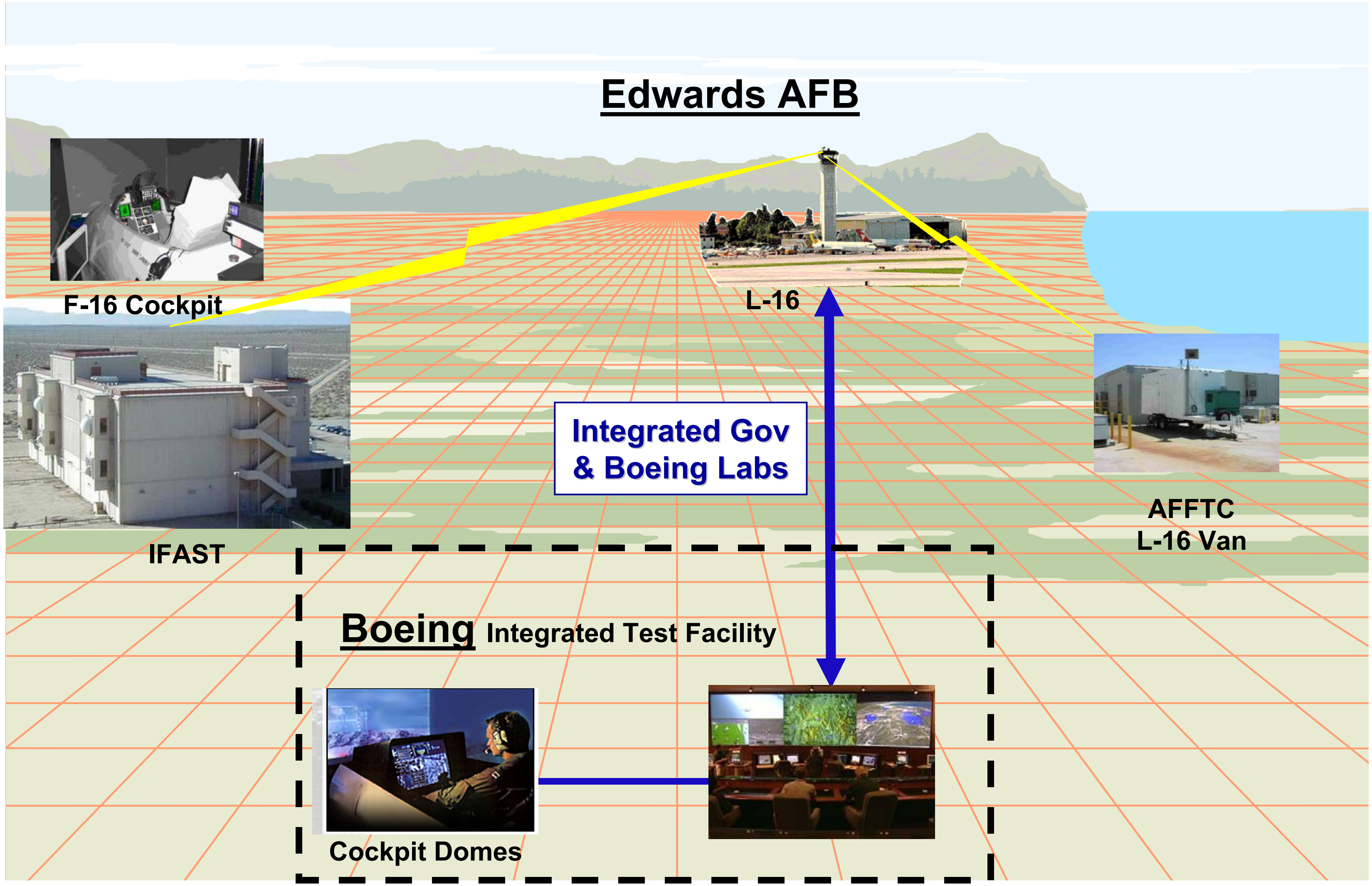
- **Implications of Interdependent DT&E/M&S Relationship**
  - Less Testing Needed…Less Time Needed…Less Dollars Needed….
  - Better Reputation…More Customers….
  - Increase work for DT
    - Ability to test more test articles (increase ***throughput***)
    - Higher quality product
  - NCO/W natural “marriage” between DT&E and M&S
    - **Can’t do it all with M&S or DT&E alone**
    - **Full spectrum of LVC**

How AFFTC connects DT and M&S

- **AFFTC has successfully teamed with Boeing via CRADA to:**
  - Cross government and contractor networks
  - Tied both M&S networks together
    - Network connectivity enabled the AFFTC and Boeing to conduct exercises using Hardware in the Loop simulators
      - **AFFTC – F-16 IFAST simulator**
      - **Boeing – F-15, F-18, AWACS 4045 (simulators)**
    - Also have used other Link 16 assets in demonstrations
      - **AFFTC Network Mission Support System (in particular the Air Defense System Integrator (ADSI))**
      - **Link 16 Vans**
    - AFFTC also partnering with Boeing in JEFX 06 through AFFTC DREN link

M&S Infrastructure Integration Demo – June 2005

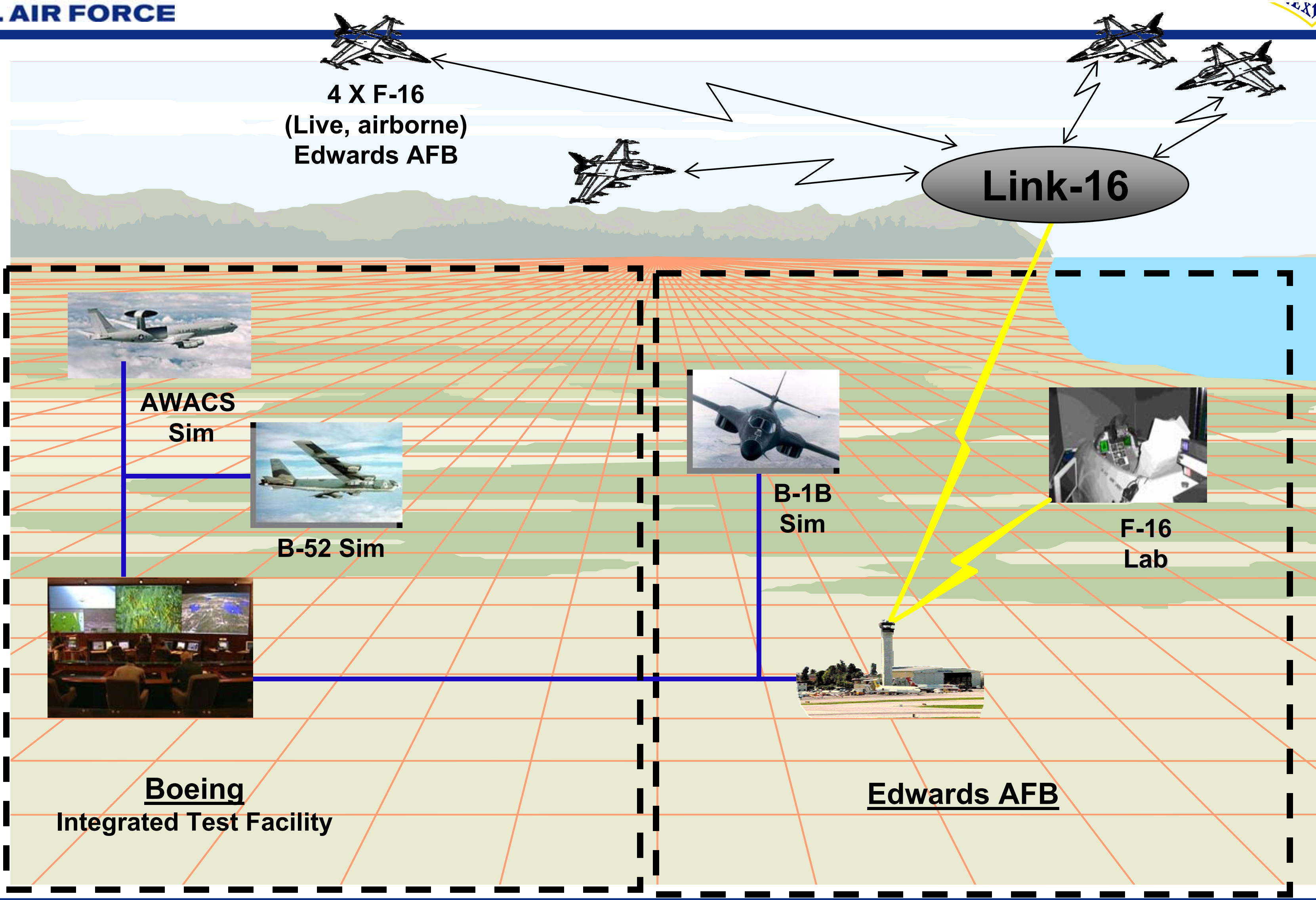
Boeing Palmdale/AFFTC Edwards AFB



We are THE path to success for delivering warfighting capabilities

Live & Virtual Data Link Integration Demonstration – December 2005

Boeing Palmdale/AFFTC Edwards AFB



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JEFX06
– Virtual Warfighter M&S Infrastructure Activity

April 2006

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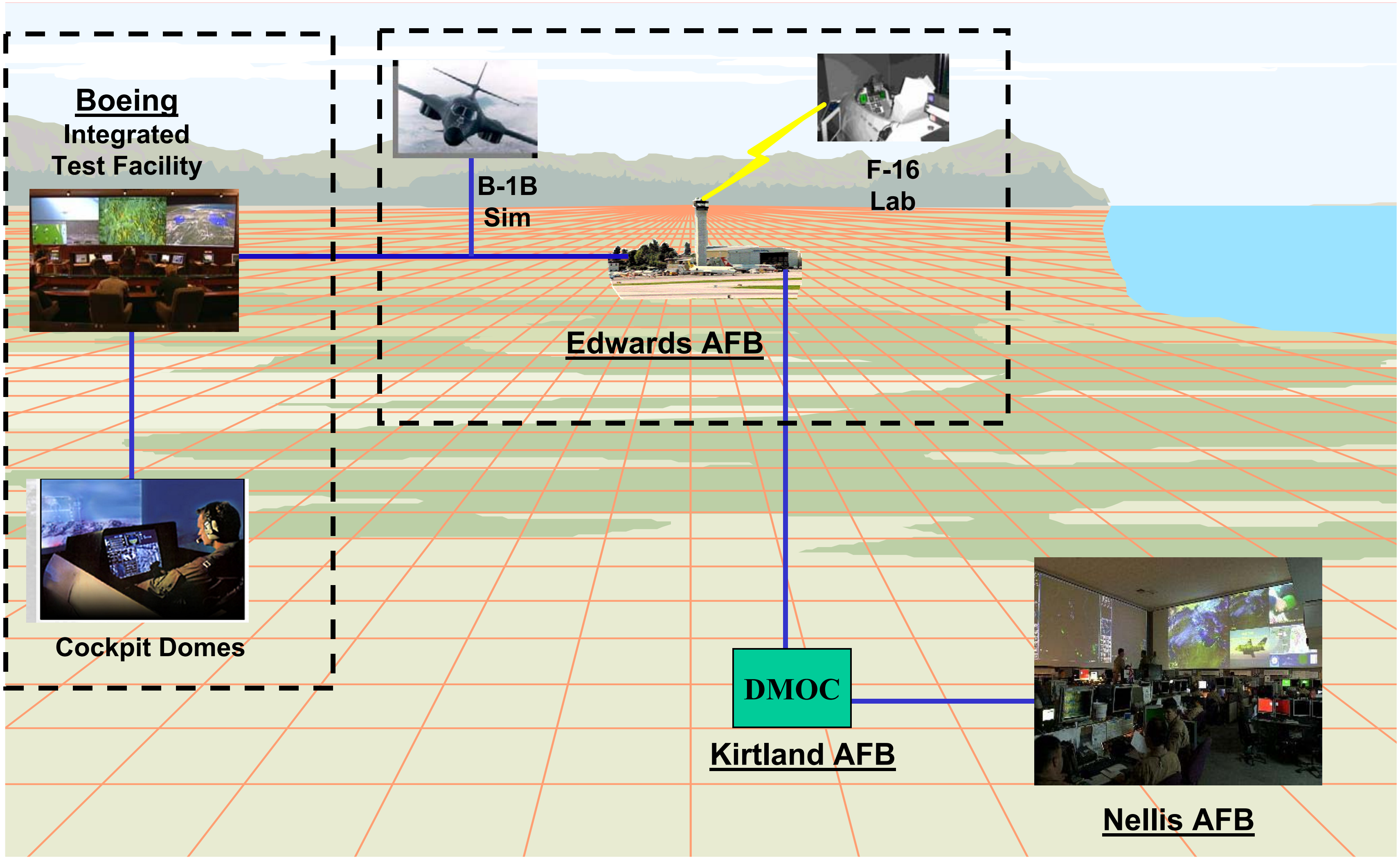

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Recommendations

- **Develop Ways for better DT/M&S Partnership**
  - Look at how DT&E uses M&S data in testing today
    - Is M&S used to help determine how much testing is enough?
    - Are M&S data used to do better DT?
  - Look at how DT&E community feeds test data to M&S community and vice versa
    - Are test data used to refine M&S Models?
  - Look at how DT/M&S community is working together in NCO/W
    - Are there lessons learned that can apply to DT&E/M&S communities elsewhere?

How to Improve the Effectiveness, Efficiency, and Integration of Test & Evaluation (T&E) and Modeling and Simulation (M&S)

Dr. Mark J. Kiemele
Air Academy Associates

NDIA Conference on T&E and M&S
Jacksonville, FL
March 6, 2006

Air Academy Associates

Agenda

- Some Basic Definitions
- The Heart and Soul of Multivariate Testing
- Integrating T&E with M&S
- Examples of Iterative Use of Modeling and Simulation
- Summary of "Modeling the Simulator"

Some Basic Definitions

- **System:** a collection of entities which act and interact together to achieve some goal

- **Model:** a simplified representation of a system developed for the purpose of studying a system

- **Simulation:** the manipulation of a model in such a way that it allows the investigation of the performance of a system.

- **Modeling and Simulation:** a discipline for developing a level of understanding of the interaction of the parts of a system, and of the system as a whole

About Models

All models are simplifications of reality.

There is always a tradeoff as to what level of detail should be included in the model:

<u>If too little detail</u>, there is a risk of missing relevant interactions and the resultant model does not promote understanding

<u>If too much detail</u>, there is a risk of overly complicating the model and actually preclude the development of understanding

The goodness of a model depends on the extent to which it promotes understanding

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Types of Models

High-Fidelity Models:

- many variables and many interactions
- highly detailed and complex
- needed for visualization
- difficult to manipulate

Low-Fidelity Models:

- much fewer number of variables
- can be manipulated more easily
- provides higher-level view of system
- presents a more aggregate view of the system

Types of Simulation

Deterministic Simulation:

- for each combination of inputs parameters, there is one and only one output value
- y = f(x)

Monte Carlo Simulation:

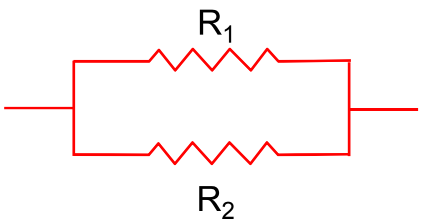
- provides for variability in the inputs
- y = f(x + variation), where the variation is modeled as some probability distribution

Discrete Event Simulation:

- studies a sequence of countable events
- assumption is that nothing of importance takes place between events

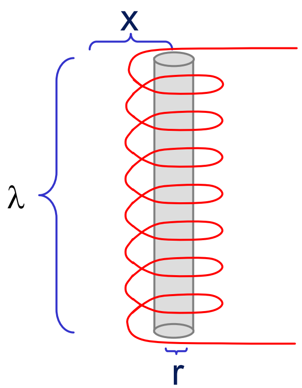
Examples of Low Fidelity Models (Transfer Functions)

- Engineering Relationships
  - $V = IR$
  - $F = ma$



The equation for the impedance (Z) through this circuit is defined by:

$$Z = \frac{R_1 \cdot R_2}{R_1 + R_2}$$



The equation for magnetic force at a distance X from the center of a solenoid is:

$$H = \frac{NI}{2\lambda}\left[\frac{.5\lambda + x}{\sqrt{r^2 + (.5\lambda + x)^2}} + \frac{.5\lambda - x}{\sqrt{r^2 + (.5\lambda - x)^2}}\right]$$

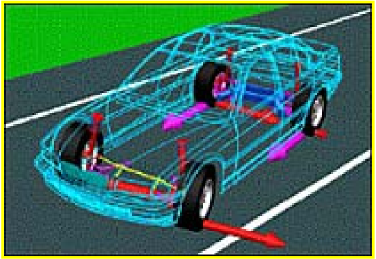
Where

N: total number of turns of wire in the solenoid
I: current in the wire, in amperes
r: radius of helix (solenoid), in cm
λ: length of the helix (solenoid), in cm
x: distance from center of helix (solenoid), in cm
H: magnetizing force, in amperes per centimeter

Examples of High Fidelity Simulation Models

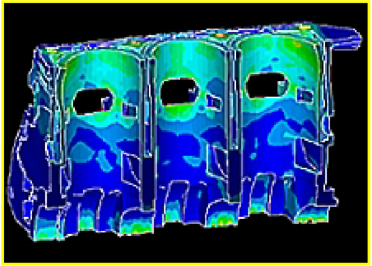
Mechanical motion: **Multibody kinetics and dynamics**

- ADAMS®
- DADS



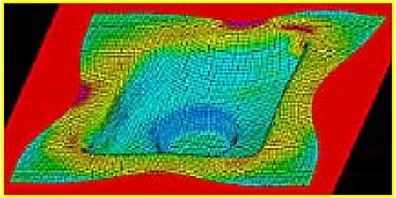
Implicit Finite Element Analysis: **Linear and nonlinear statics, dynamic response**

- MSC.Nastran™, MSC.Marc™
- ANSYS®
- Pro MECHANICA
- ABAQUS® Standard and Explicit
- ADINA



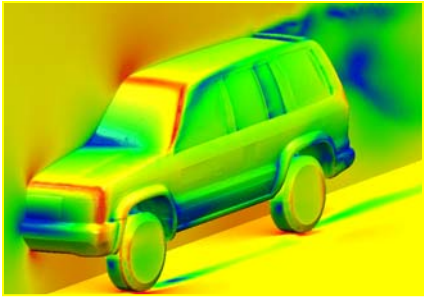
Explicit Finite Element Analysis : **Impact simulation, metal forming**

- LS-DYNA
- RADIOSS
- PAM-CRASH®, PAM-STAMP



General Computational Fluid Dynamics: **Internal and external flow simulation**

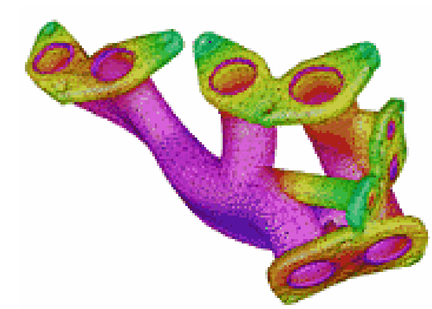
- STAR-CD
- CFX-4, CFX-5
- FLUENT®, FIDAP™
- PowerFLOW®



Examples of High Fidelity Simulation Models

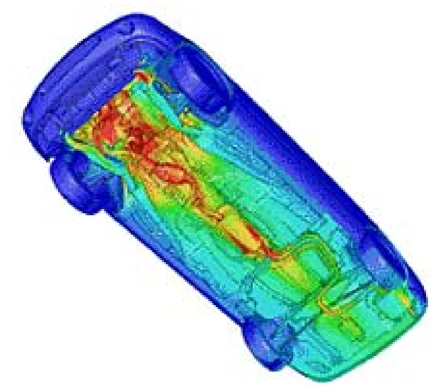
Preprocessing: Finite Element Analysis and Computational Fluid Dynamics mesh generation

- ICEM-CFD
- Gridgen
- Altair® HyperMesh®
- I-deas®
- MSC.Patran
- TrueGrid®
- GridPro
- FEMB
- ANSA



Postprocessing: Finite Element Analysis and Computational Fluid Dynamics results visualization

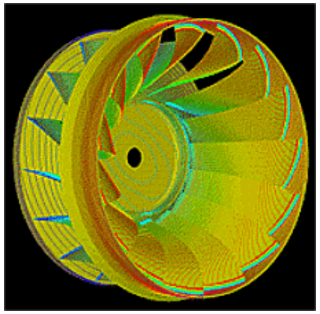
- Altair® HyperMesh®
- I-deas
- MSC.Patran
- FEMB
- EnSight
- FIELDVIEW
- ICEM CFD Visual3 2.0 (PVS)
- COVISE



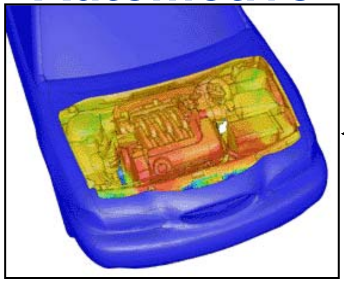
Applications of Modeling and Simulation

Power

Simulation of stress and vibrations of turbine assembly for use in nuclear power generation



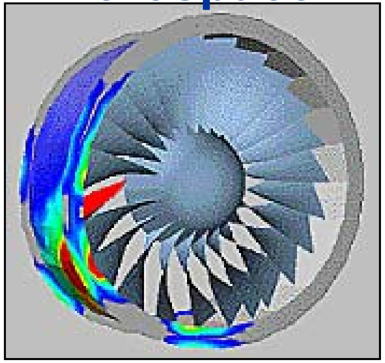
Automotive



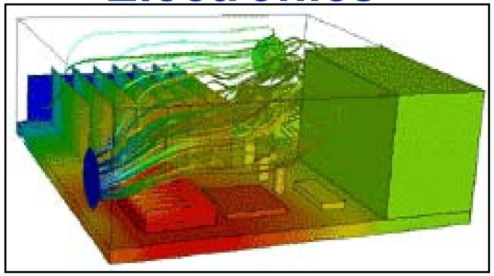
Simulation of underhood thermal cooling for decrease in engine space and increase in cabin space and comfort

Aerospace

Evaluation of dual bird-strike on aircraft engine nacelle for turbine blade containment studies



Electronics



Evaluation of cooling air flow behavior inside a computer system chassis

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Reasons for Test & Evaluation

Functional Compatibility:

- to determine if various components or subassemblies work together

Screening:

- to separate the critical parameters from those that are not critical with regard to functionality or performance capability

Modeling:

- to build prediction capability of the performance measures and perform sensitivity and interaction analyses on the critical parameters

Introduction to High Throughput Testing (HTT)

- A recently developed technique based on combinatorics
- Used to test myriad combinations of many factors (typically qualitative) where the factors could have many levels
- Uses a minimum number of runs or combinations to do this
- Software (e.g., ProTest) is needed to select the minimal subset of all possible combinations to be tested so that all n-way combinations are tested.
- HTT is not a DOE technique, although the terminology is similar
- A run or row in an HTT matrix is, like DOE, a combination of different factor levels which, after being tested, will result in a successful or failed run
- HTT has its origins in the pharmaceutical business where in drug discovery many chemical compounds are combined together (combinatorial chemistry) at many different strengths to try to produce a reaction.
- Other industries are now using HTT, e.g., software testing, materials discovery, IT (see IT example on next page)

HTT Example

- An IT function in a company wanted to test all 2-way combinations of a variety of computer configuration-related options or levels to see if they would function properly together.
- Here are the factors with each of their options:

Motherboards (5)	:	Gateway, ASUS, Micronics, Dell, Compaq
RAM (3)	:	128 MB, 256 MB, 512 MB
BIOS (3)	:	Dell, Award, Generic
CD (3)	:	Generic, Teac, Sony
Monitor (5)	:	Viewsonic, Sony, KDS, NEC, Generic
Printer (3)	:	HP, Lexmark, Cannon
Voltage (2)	:	220, 110
Resolution (2)	:	800x600, 1024x768

- How many total combinations are there?
- What is the minimum number of these combinations we will have to test (and which ones are they) in order to determine if every 2-way combination (e.g., Dell Bios with Teac CD) will indeed work properly together?
- To answer this question, we used Pro-Test software. The answer is 25 runs and those 25 combinations are shown on the next page.

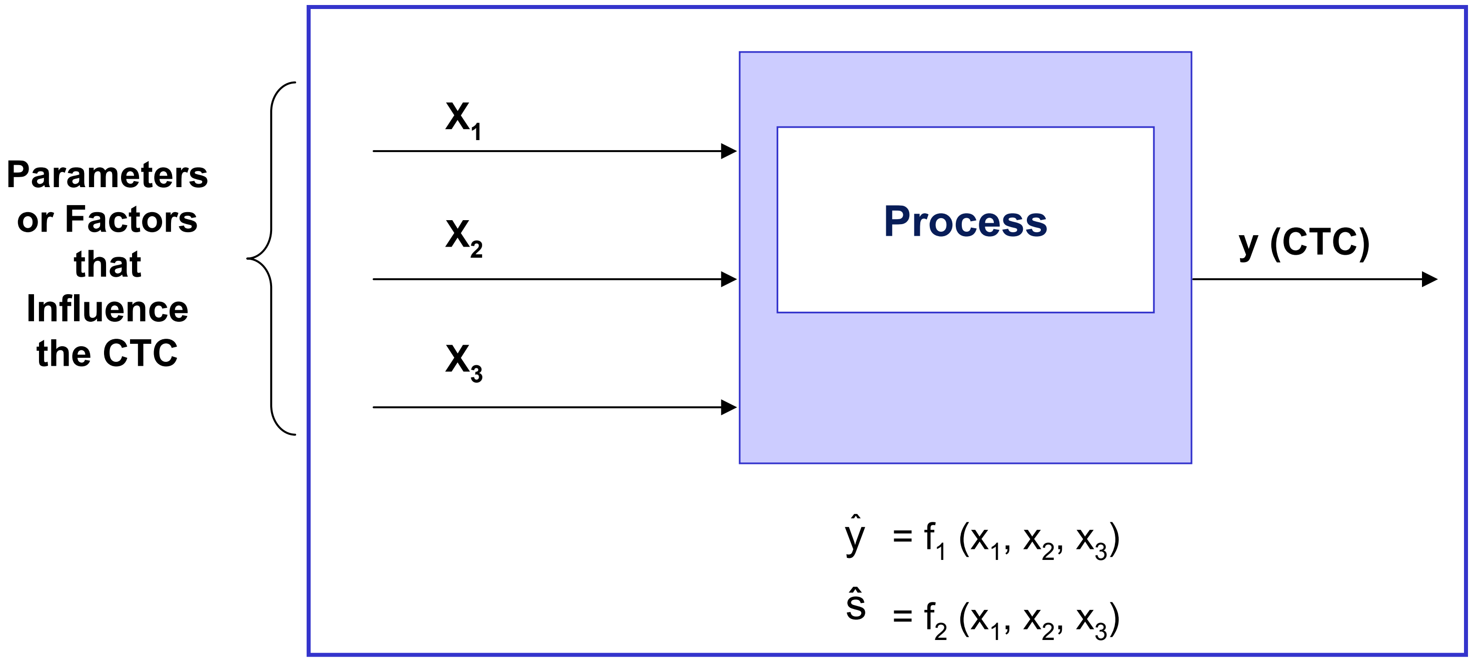
High Throughput Testing (HTT)

(for all two-way combinations)

Full Factorial = 8100 runs HTT = 25 runs

	5 Levels	*3 Levels*	*3 Levels*	*3 Levels*	*5 Levels*	*3 Levels*	*2 Levels*	*2 Levels*
	Motherboard	**RAM**	**BIOS**	**CD**	**Monitor**	**Printer**	**Voltage**	**Resolution**
Case 1	ASUS	256 MB	Dell	Generic	Viewsonic	Lexmark	110 V	800 x 600
Case 2	Compaq	512 MB	Dell	Teac	Sony	HP	220 V	1024 x 768
Case 3	Gateway	128 MB	Generic	Sony	KDS	Cannon	220 V	800 x 600
Case 4	Dell	128 MB	Award	Teac	NEC	Cannon	110 V	1024 x 768
Case 5	Micronics	256 MB	Generic	Teac	Generic	Lexmark	220 V	1024 x 768
Case 6	Gateway	256 MB	Award	Sony	Sony	HP	110 V	1024 x 768
Case 7	Micronics	512 MB	Award	Generic	Viewsonic	Cannon	220 V	1024 x 768
Case 8	ASUS	512 MB	Generic	Teac	KDS	HP	220 V	1024 x 768
Case 9	Compaq	128 MB	Award	Generic	Generic	HP	110 V	800 x 600
Case 10	Micronics	512 MB	Generic	Teac	Sony	Lexmark	110 V	800 x 600
Case 11	Dell	256 MB	Award	Generic	KDS	Lexmark	110 V	1024 x 768
Case 12	Gateway	512 MB	Dell	Sony	Generic	Lexmark	110 V	1024 x 768
Case 13	Compaq	256 MB	Generic	Sony	Viewsonic	Cannon	220 V	1024 x 768
Case 14	ASUS	128 MB	Dell	Sony	NEC	Cannon	220 V	800 x 600
Case 15	Micronics	128 MB	Dell	Sony	KDS	Lexmark	220 V	800 x 600
Case 16	Gateway	128 MB	Generic	Teac	Viewsonic	HP	110 V	800 x 600
Case 17	Dell	128 MB	Dell	Sony	Sony	Cannon	110 V	1024 x 768
Case 18	ASUS	256 MB	Award	Sony	Generic	Cannon	220 V	1024 x 768
Case 19	Compaq	512 MB	Dell	Sony	NEC	Lexmark	110 V	800 x 600
Case 20	Gateway	256 MB	Generic	Generic	NEC	Cannon	220 V	800 x 600
Case 21	Micronics	512 MB	Generic	Teac	NEC	HP	220 V	800 x 600
Case 22	ASUS	256 MB	Generic	Generic	Sony	HP	110 V	800 x 600
Case 23	Dell	512 MB	Generic	Sony	Viewsonic	HP	220 V	1024 x 768
Case 24	Compaq	256 MB	Dell	Generic	KDS	Cannon	220 V	1024 x 768
Case 25	Dell	128 MB	Generic	Sony	Generic	HP	110 V	800 x 600

Test and Evaluation for Screening and Modeling



Where does the data for evaluation come from?

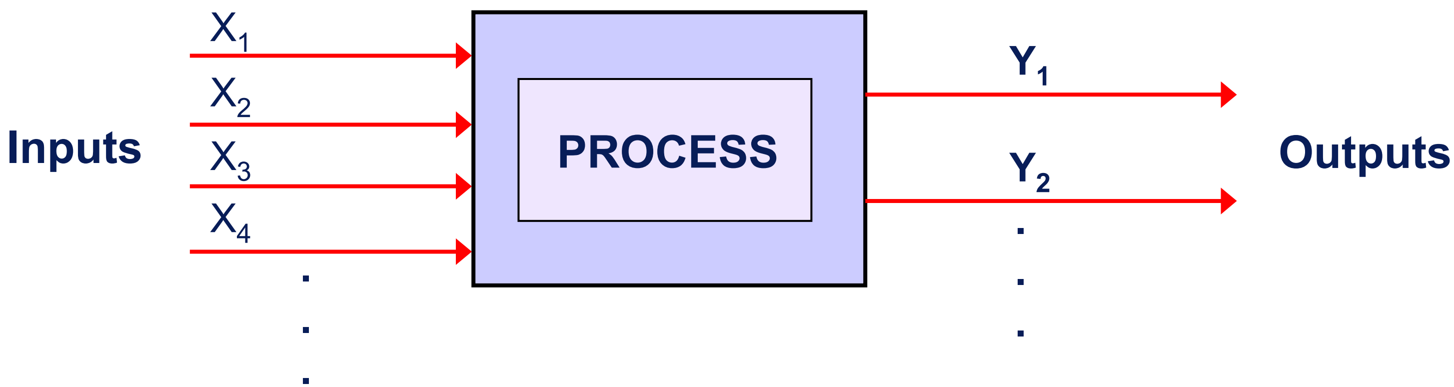
- Design of Experiments (Multivariate Testing)
- Historical Data Analysis
- Simulation

Design of Experiments (DOE)

- An optimal data collection methodology
- “Interrogates” the process
- Used to identify important relationships between input and output factors
- Identifies important interactions between process variables
- Can be used to optimize a process
- Changes “I think” to “I know”

What Is a Designed Experiment?

Purposeful changes of the inputs (factors) in order to observe corresponding changes in the output (response).



Run	X_1	X_2	X_3	X_4	Y_1	Y_2	. . . . . .	$\bar{Y}$	S_Y
1									
2									
3									
.									
.									

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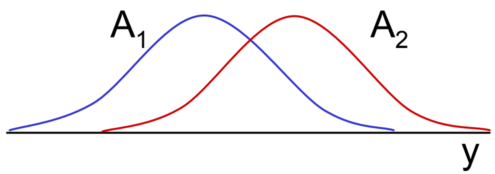
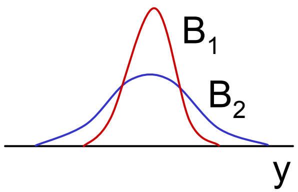
DOE: Determining How Inputs Affect Outputs

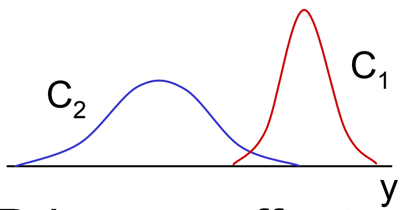
i) Factor A affects the average



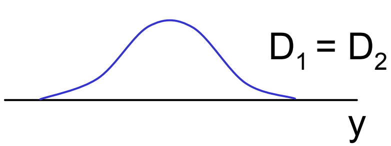
ii) Factor B affects the standard deviation



iii) Factor C affects the average and the standard deviation



iv) Factor D has no effect



Today's Methods of Experimentation: Orthogonal or Nearly Orthogonal Designs

- FULL FACTORIALS (for small numbers of factors)
- FRACTIONAL FACTORIALS
- PLACKETT - BURMAN
- LATIN SQUARES
- HADAMARD MATRICES

Taguchi Designs

- BOX - BEHNKEN DESIGNS
- CENTRAL COMPOSITE DESIGNS

SIMPLE DEFINITION OF TWO-LEVEL ORTHOGONAL DESIGNS

Run	Actual Settings	Coded Matrix	Response
1			
2			
3			
4			
5			
6			
7			
8			

DOE "Market Research" Example

Purpose:

1. Determine the relative importance of product attributes in the consumer choice process

2. Determine the composition of the most preferred product

3. Estimate market share of a given product

4. Segment the market as to their preferred product profile

DOE "Market Research" Example (cont.)

Suppose that, in the auto industry, we would like to investigate the following automobile attributes (i.e., factors), along with accompanying levels of those attributes:

A: Brand of Auto:	-1 = foreign		+1 = domestic
B: Auto Color:	-1 = light	0 = bright	+1 = dark
C: Body Style:	-1 = 2-door	0 = 4-door	+1 = sliding door/hatchback
D: Drive Mechanism:	-1 = rear wheel	0 = front wheel	+1 = 4-wheel
E: Engine Size:	-1 = 4-cylinder	0 = 6-cylinder	+1 = 8-cylinder
F: Interior Size:	-1 ≤ 2 people	0 = 3-5 people	+1 ≥ 6 people
G: Gas Mileage:	-1 ≤ 20 mpg	0 = 20-30 mpg	+1 ≥ 30 mpg
H: Price:	-1 ≤ $20K	0 = $20-$40K	+1 ≥ $40K

In addition, suppose the respondents chosen to provide their preferences to product profiles are taken based on the following demographic:

J: Age:	-1 ≤ 25 years old	+1 ≥ 35 years old
K: Income:	-1 ≤ $30K	+1 ≥ $40K
L: Education:	-1 < BS	+1 ≥ BS

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DOE "Market Research" Example (cont.)

Question: Choose the best design for evaluating this scenario

Answer: L_{18} design with attributes A - H in the inner array and factors J, K, and L in the outer array, resembling an L_{18} robust design, as shown below:

									L	-	+	-	+	-	+	-	+		
									K	-	-	+	+	-	-	+	+		
									J	-	-	-	-	+	+	+	+		
Run*	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**		y_1	y_2	y_3	y_4	y_5	y_6	y_7	y_8	$\bar{y}$	s
1	-	-	-	-	-	-	-	-											
2	-	-	0	0	0	0	0	0											
3	-	-	+	+	+	+	+	+											
4	-	0	-	-	0	0	+	+											
5	-	0	0	0	+	+	-	-											
6	-	0	+	+	-	-	0	0											
7	-	+	-	0	-	+	0	+											
8	-	+	0	+	0	-	+	-											
9	-	+	+	-	+	0	-	0											
10	+	-	-	+	+	0	0	-											
11	+	-	0	-	-	+	+	0											
12	+	-	+	0	0	-	-	+											
13	+	0	-	0	+	-	+	0											
14	+	0	0	+	-	0	-	+											
15	+	0	+	-	0	+	0	-											
16	+	+	-	+	0	+	-	0											
17	+	+	0	-	+	-	0	+											
18	+	+	+	0	-	0	+	-											

Segmentation of the population or

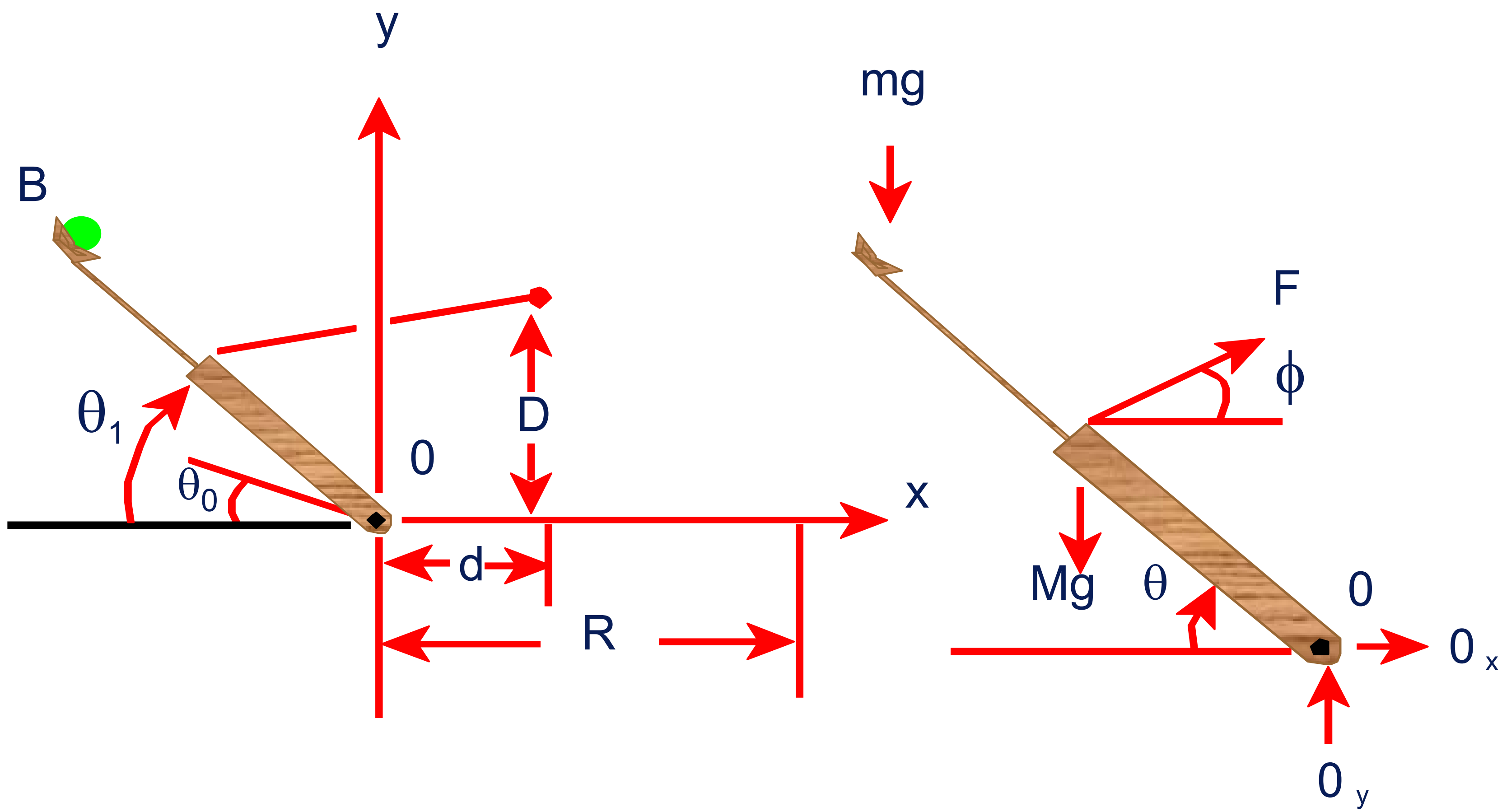
<u>Respondent Profiles</u>

* 18 different product profiles

Catapulting Power into Modeling

Statapult® Catapult

Catapulting Power into Modeling



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The Theoretical Approach

$$I_0\ddot{\theta} = r_F F(\theta)\sin\theta\cos\varphi - (Mgr_G + mgr_B)\sin\theta \qquad \tan\phi = \frac{D - r_F\sin\theta}{d + r_F\cos\theta},$$

$$\frac{1}{2}I_0\dot{\theta}^2 = r_F\int_{\theta_0}^{\theta} F(\theta)\sin\theta\cos\varphi\, d\theta - (Mgr_G + mgr_B)(\sin\theta - \sin\theta_0)$$

$$\frac{1}{2}I_0\dot{\theta}_1^2 = r_F\int_{\theta_0}^{\theta_1} F(\theta)\sin\theta\cos\varphi\, d\theta - (Mgr_G + mgr_B)(\sin\theta_1 - \sin\theta_0).$$

$$x = v_B\cos\left(\frac{\pi}{2} - \theta_1\right)t - \frac{1}{2}r_B\cos\theta_1 \qquad y = r_B\sin\theta_1 + v_B\sin\left(\frac{\pi}{2} - \theta_1\right)t - \frac{1}{2}gt^2.$$

$$r_B\sin\theta_1 + (R + r_B\cos\theta_1)\tan\left(\frac{\pi}{2} - \theta_1\right) - \frac{g}{2V_B^2}\frac{(R + r_B\cos\theta_1)^2}{\cos^2\left(\frac{\pi}{2} - \theta_1\right)} = 0.$$

$$\frac{gI_0}{4r_B}\frac{(R + r_B\cos\theta_1)^2}{\cos^2\left(\frac{\pi}{2} - \theta_1\right)\left[r_B\sin\theta_1 + (R + r_B\cos\theta_1)\tan\left(\frac{\pi}{2} - \theta_1\right)\right]}$$

$$= r_F\int_{\theta_0}^{\theta_1} F(\theta)\sin\theta\cos\phi\, d\theta - (Mgr_G + mgr_B)(\sin\theta_1 - \sin\theta_0).$$

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Statapult® Exercise
(DOE demonstration)

	Actual Factors		Coded Factors			Response Values			
Run	A	B	A	B	AB	Y_1	Y_2	$\bar{Y}$	S
1									
2									
3									
4									

Avg –	
Avg +	
Δ	

$\hat{Y} =$

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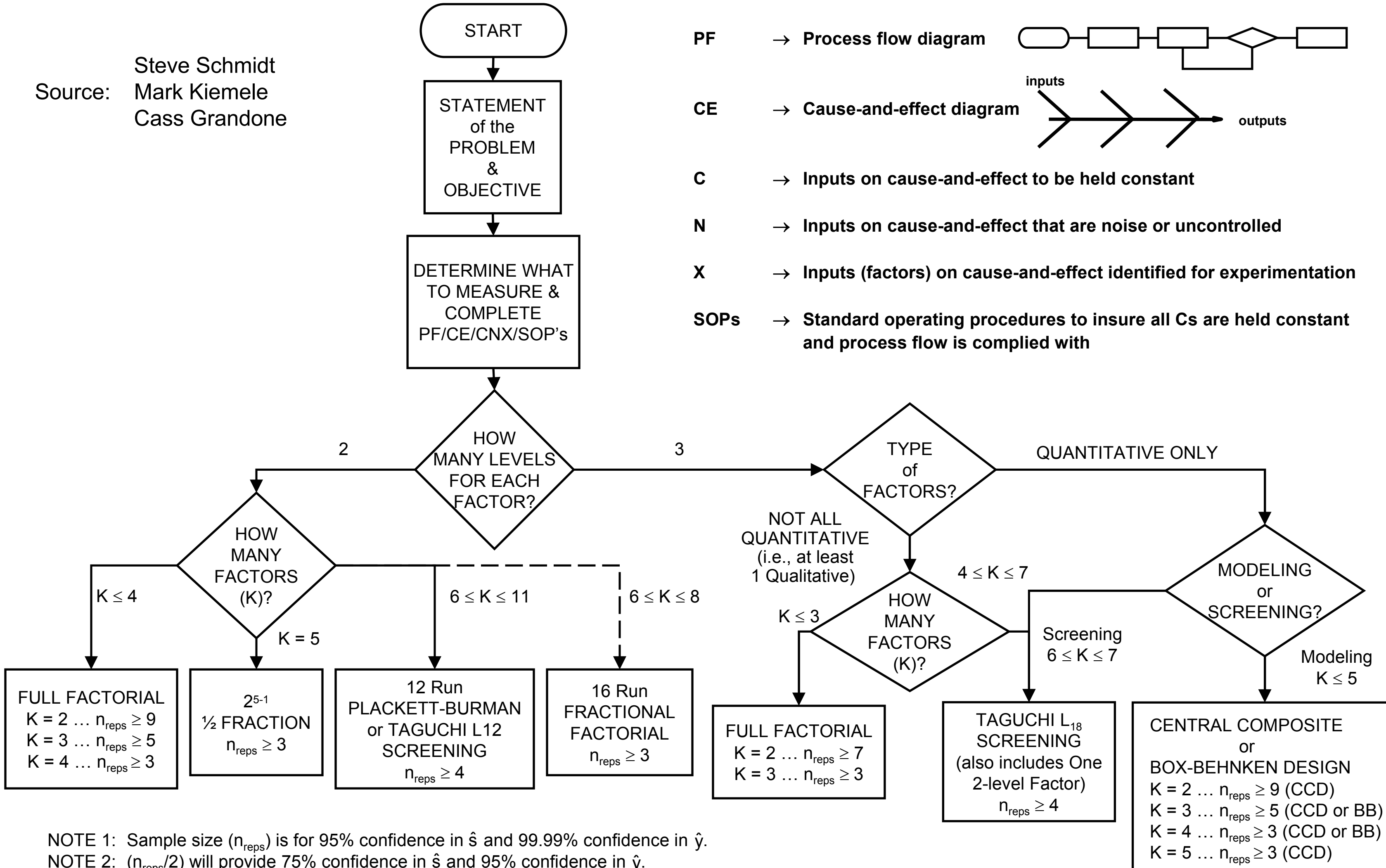
KISS Guidelines for Choosing an Experimental Design

KISS - Keep It Simple Statistically

Source: Steve Schmidt
Mark Kiemele
Cass Grandone



PF → **Process flow diagram**

CE → **Cause-and-effect diagram** inputs outputs

C → **Inputs on cause-and-effect to be held constant**

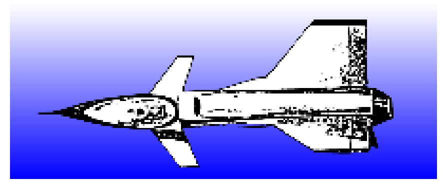
N → **Inputs on cause-and-effect that are noise or uncontrolled**

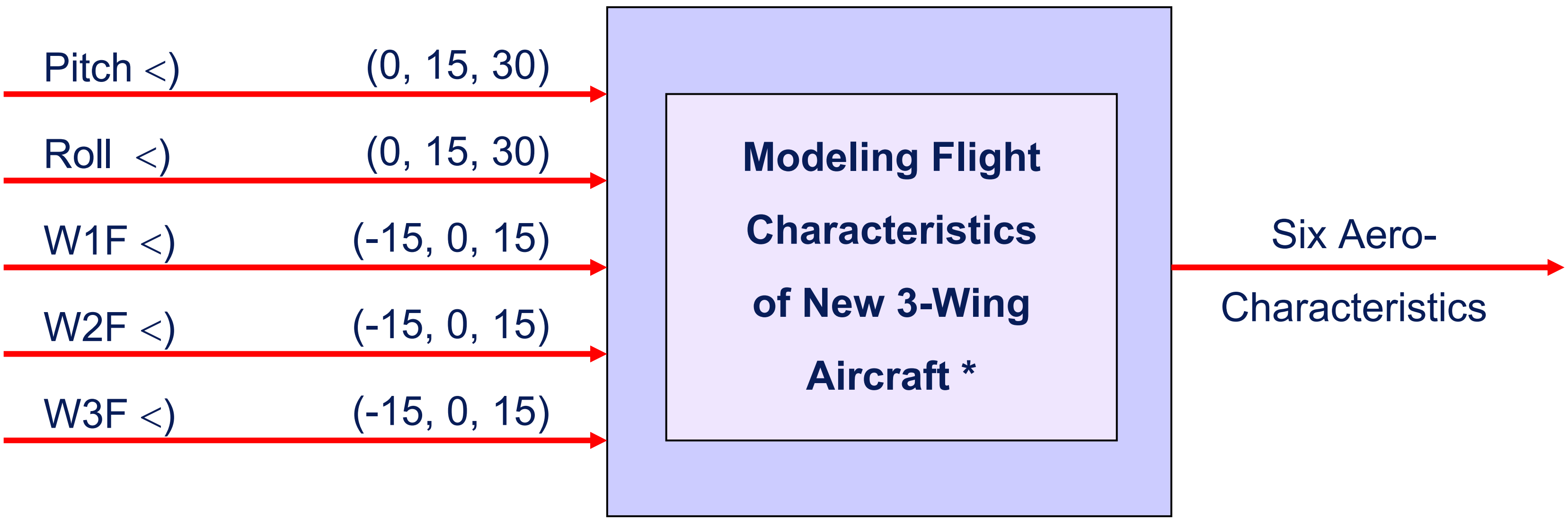
X → **Inputs (factors) on cause-and-effect identified for experimentation**

SOPs → **Standard operating procedures to insure all Cs are held constant and process flow is complied with**

NOTE 1: Sample size (n_{reps}) is for 95% confidence in $\hat{s}$ and 99.99% confidence in $\hat{y}$.
NOTE 2: ($n_{reps}/2$) will provide 75% confidence in $\hat{s}$ and 95% confidence in $\hat{y}$.
NOTE 3: The 12 Run Plackett-Burman or L12 is very sensitive to large numbers of interactions. If this is the case, you would be better off using the 16 Run Fractional Factorial or a smaller number of variables in 2 or more full factorial experiments.
NOTE 4: For more complete 2-level design options, see next page.

Value Delivery: Reducing Time to Market for New Technologies





- **Total # of Combinations = 3^5 = 243**
- **Central Composite Design: n = 30**

* Patented by Dr. Bert Silich

Aircraft Equations

C_L = .233 + .008(P)^2 + .255(P) + .012(R) - .043(WD1) - .117(WD2) + .185(WD3) + .010(P)(WD3) - .042(R)(WD1) + .035(R)(WD2) + .016(R)(WD3) + .010(P)(R) - .003(WD1)(WD2) - .006(WD1)(WD3)

C_D = .058 + .016(P)^2 + .028(P) - .004(WD1) - .013(WD2) + .013(WD3) + .002(P)(R) - .004(P)(WD1) - .009(P)(WD2) + .016(P)(WD3) - .004(R)(WD1) + .003(R)(WD2) + .020(WD1)^2 + .017(WD2)^2 + .021(WD3)^2

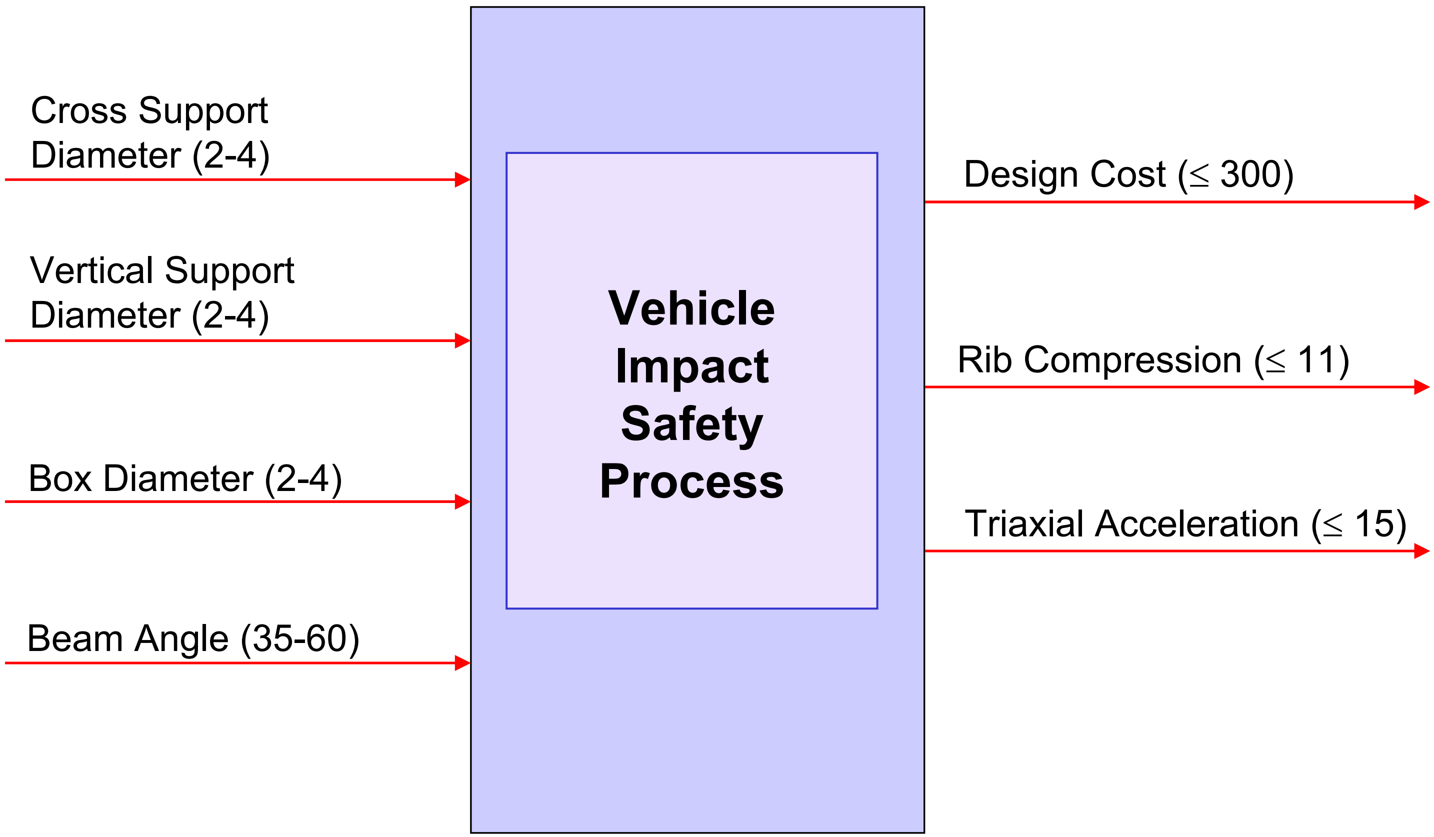
C_Y = -.006(P) - .006(R) + .169(WD1) - .121(WD2) - .063(WD3) - .004(P)(R) + .008(P)(WD1) - .006(P)(WD2) - .008(P)(WD3) - .012(R)(WD1) - .029(R)(WD2) + .048(R)(WD3) - .008(WD1)^2

C_M = .023 - .008(P)^2 + .004(P) - .007(R) + .024(WD1) + .066(WD2) - .099(WD3) - .006(P)(R) + .002(P)(WD2) - .005(P)(WD3) + .023(R)(WD1) - .019(R)(WD2) - .007(R)(WD3) + .007(WD1)^2 - .008(WD2)^2 + .002(WD1)(WD2) + .002(WD1)(WD3)

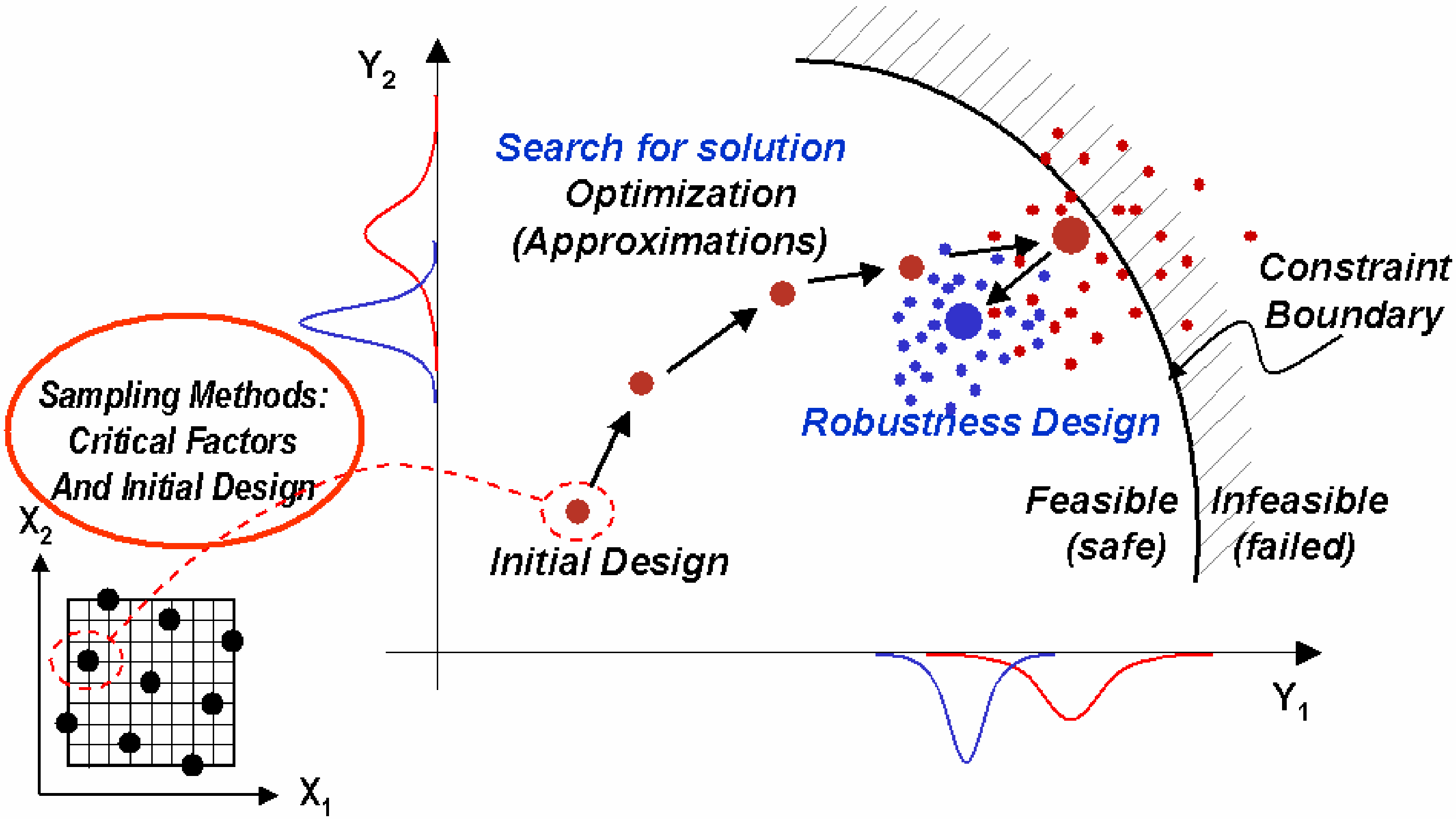
C_{YM}= .001(P) + .001(R) - .050(WD1) + .029(WD2) + .012(WD3) + .001(P)(R) - .005(P)(WD1) - .004(P)(WD2) - .004(P)(WD3) + .003(R)(WD1) + .008(R)(WD2) - .013(R)(WD3) + .004(WD1)^2 + .003(WD2)^2 - .005(WD3)^2

C_e = .003(P) + .035(WD1) + .048(WD2) + .051(WD3) - .003(R)(WD3) + .003(P)(R) - .005(P)(WD1) + .005(P)(WD2) + .006(P)(WD3) + .002(R)(WD1)

Multiple Response Optimization Simulation Example



Iterative Use of Simulation and Modeling



Applying Modeling and Simulation to Automotive Vehicle Design

IDENTIFY CTCs, CDPs → Many, Many x's → **SCREENING DESIGN (DOE PRO)** → The critical few CDP's

Examples of CTCs:

NASTRAN RADIOSS MADYMO

Integrated processes with high fidelity CAE analyses on HPC servers

Examples of Critical Design Parameters (CDPs or Xs):

y_1 = weight of vehicle

y_2 = cost of vehicle

Safety CTCs with constraints specified by FMVSS (Federal Motor Vehicle Safety Standards):

- y_3 = frontal head impact
- y_4 = frontal chest impact
- y_5 = toe board intrusion
- y_6 = hip deflection
- y_7 = rollover impact
- y_8 = side impact

RADIOSS
DYNA
MADYMO

no federal requirements on these CTCs:

- y_9 = internal aerodynamics (airflow)
- y_{10} = external aerodynamics (airflow)

CFD

- y_{11} = noise
- y_{12} = vibration (e.g., steering wheel)
- y_{13} = harshness (e.g., over bumps, shocks)
- y_{14} = durability (at 100K miles)

NASTRAN

x_1 = roof panel material

x_2 = roof panel thickness

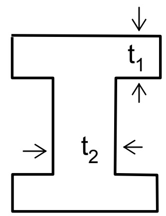
x_3 = door pillar dimensions $\Rightarrow$ i beam

x_4 = shape/geometry

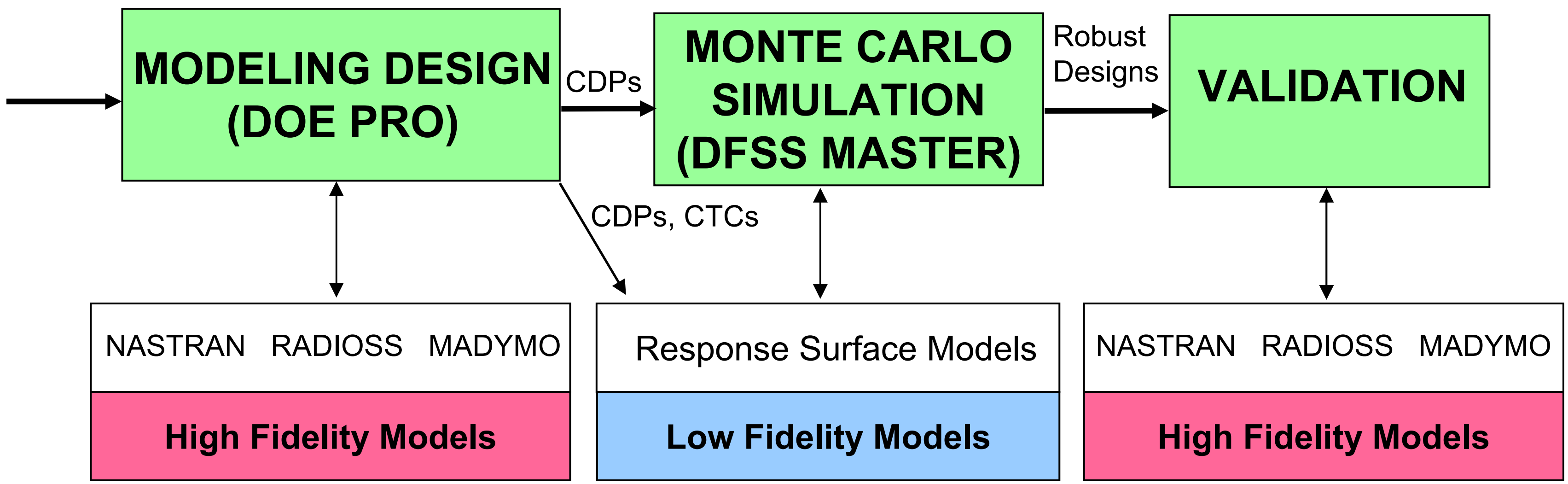
x_5 = windshield glass

x_6 = hood material, sizing and thickness

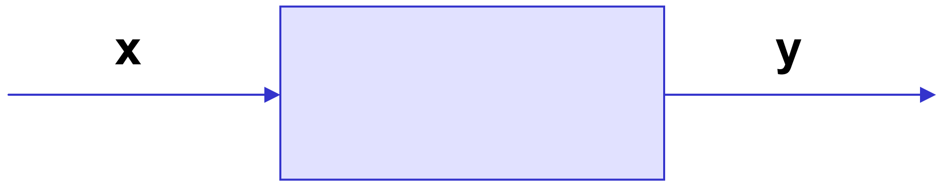
x_7 = under hood panel material, sizing and thickness



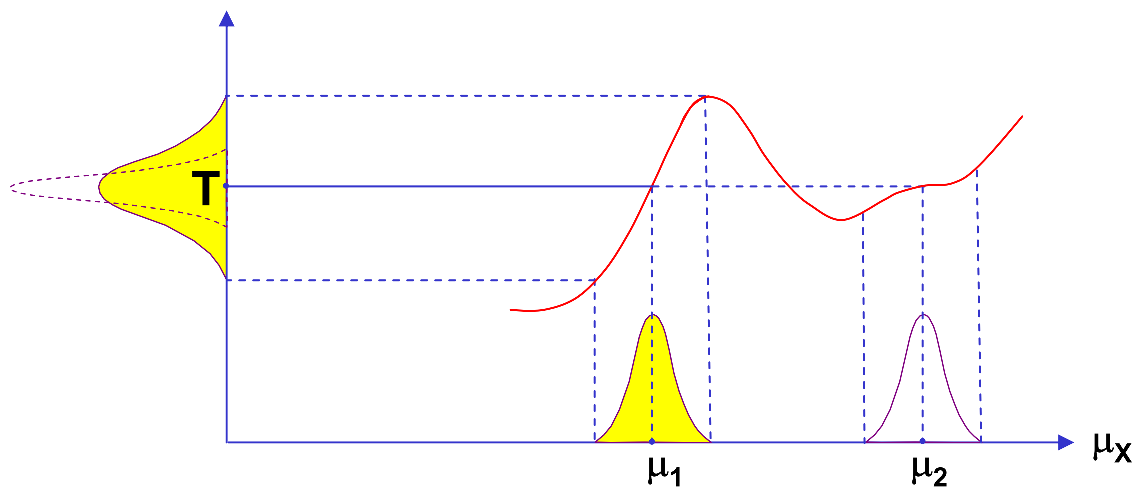
Applying Modeling and Simulation to Automotive Vehicle Design (cont.)



Why Robust Design?

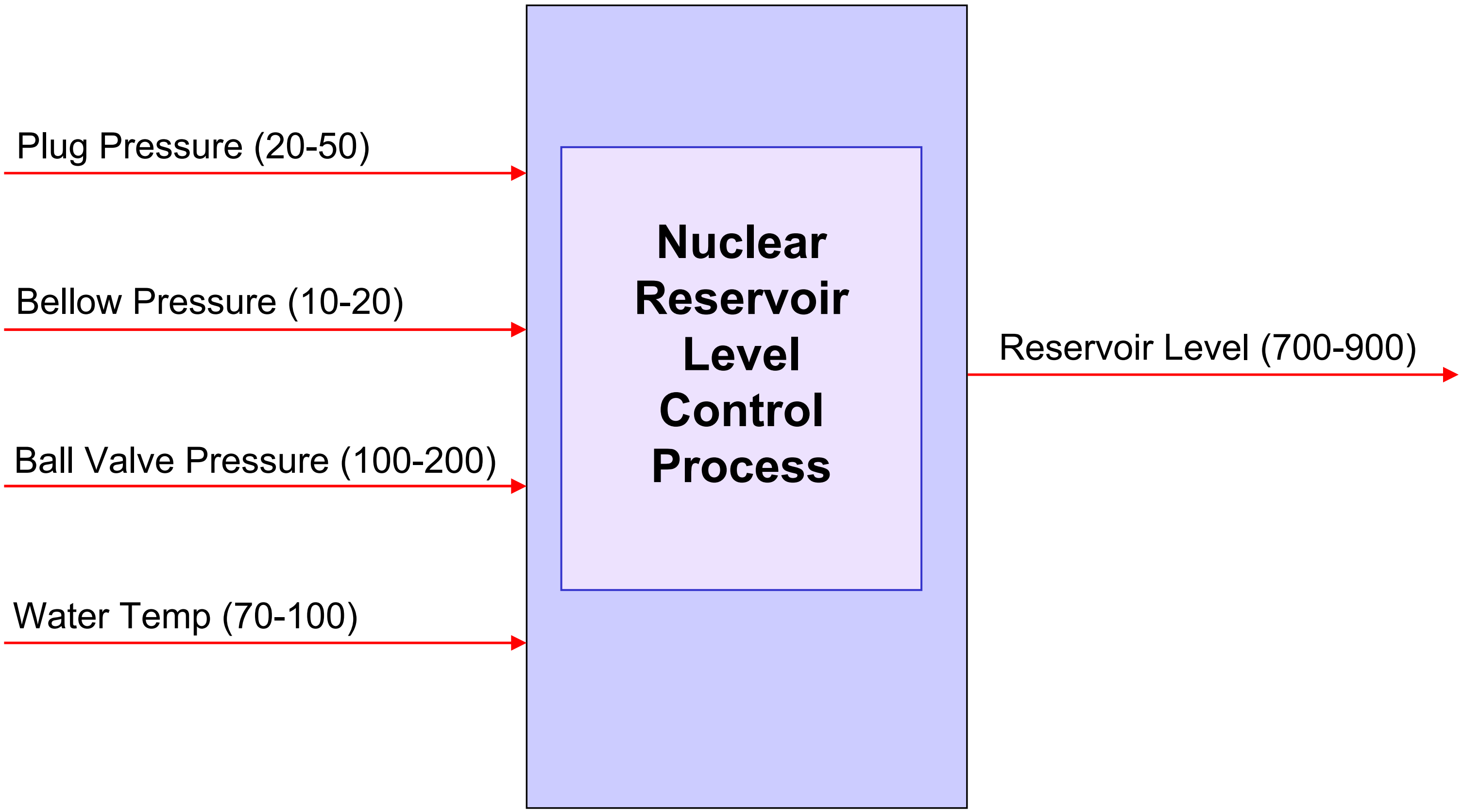


One Input

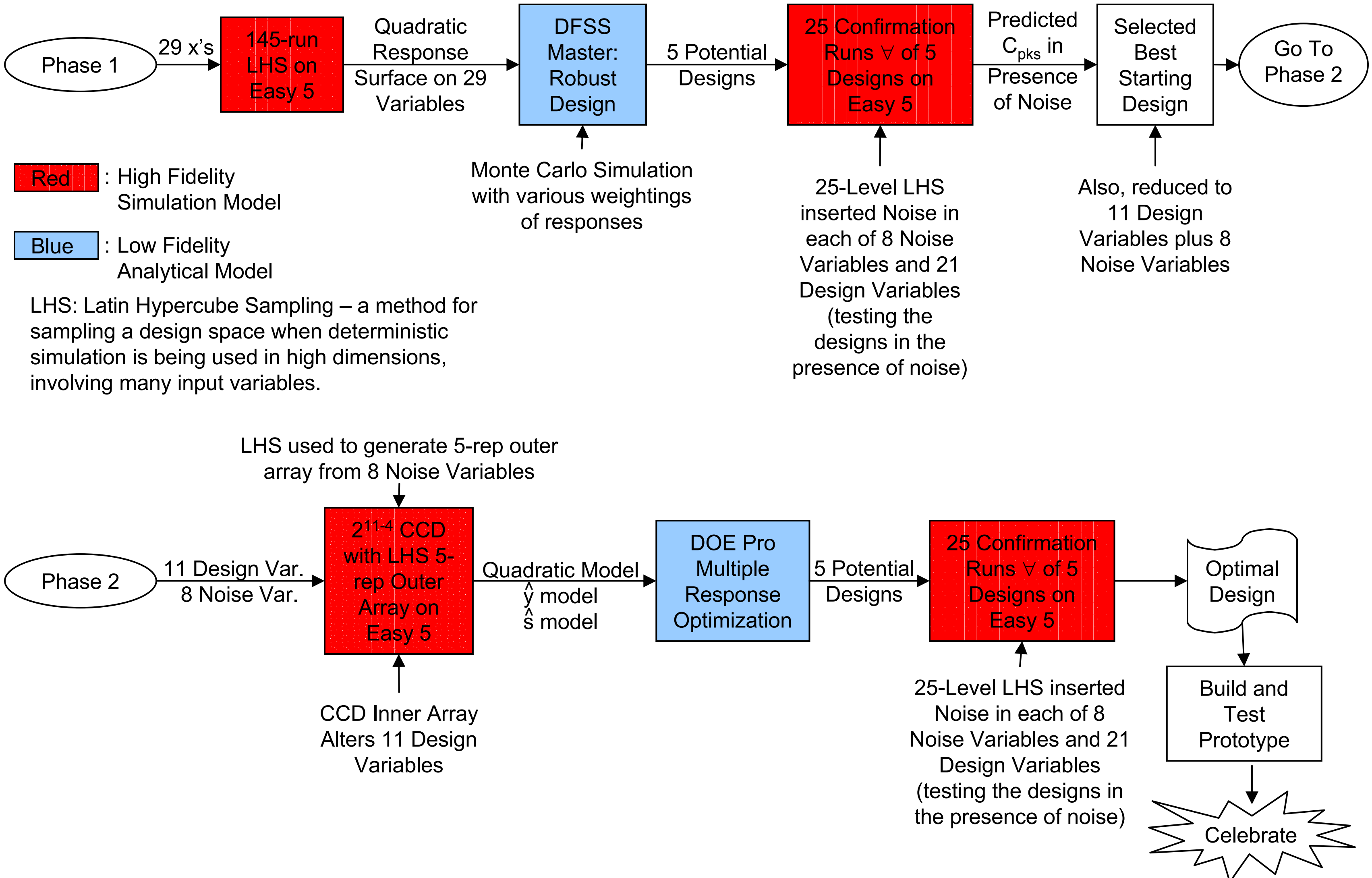


If μ_X varies, should we select μ_1 or μ_2 to hit y = T?

Robust (Parameter) Design Simulation Example



Example of Iterative Approach to Modeling and Simulation to Optimize Transmission Performance



Modeling the Simulator

Perform Screening Design Using the Simulator if necessary

↓ Critical Parameters ID'd

Perform Modeling Design Using the Simulator to Build Low Fidelity Model

↓ Transfer Function on Critical Parameters

Perform DFSS Activities (Robust Design, Tolerance Allocation) Using Transfer Function

↓ Optimized Design

Validate Design Using the Simulator

↓ Optimized Simulator

Build Prototype to Validate Design in Real World

Environments Where Simulation and Modeling Is Beneficial

- A high number of design variables
- A substantial number of design subsystems and engineering disciplines
- Interdependency and interaction between the subsystems and variables
- Multiple response variables
- Need to characterize the system at a higher level of abstraction
- Time and/or space must be compressed

The Vision of DFSS

Reactive Design Quality → DFSS → Predictive Design Quality

From

- Evolving design requirements
- Extensive design rework
- Product performance assessed by “build and test”
- Performance and producibility problems fixed <u>after</u> product in use
- Quality “tested in”

To

- Disciplined CTC flowdown
- Controlled design parameters
- Product performance modeled and simulated
- <u>Designed</u> for robust performance and producibility
- Quality “designed in”

For Further Information, Please Contact:

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NDIA, Jacksonville, FL, 8 Mar 06

U.S. AIR FORCE

U.S. AIR FORCE

Modeling and Simulation (M&S)

- M&S – "*The Good*"
  - F/A-22
  - Ranges
  - Hardware in the Loop
- M&S – "*The Bad*"
  - Complex Threat Simulators

M&S – A Word of Caution

- Joint Modeling and Simulation System (JMASS)
  - Requirements Creep
  - *We built but they did not come*
  - Blue Model Challenge

T&E Resources

- National Defense Authorization Act (NDAA) ’03
- Support Contractor Reduction (25%) over FYDP
- Personnel Reductions
- Smart Operations 21 (SO-21)

F-35 JSF Testing Challenges

- International Partner Participation
  - Desired Level of Involvement
  - Data Requirements
  - Security Guidelines

U.S. AIR FORCE

Initial Operational test and Evaluation (IOT&E)

- “Effective” – adequate to accomplish a purpose
- “Not Effective” –
- Experience
  - JSTARS
  - Predator

Defense Acquisition Performance Assessment (DAPA) Report, Jan 06

- Performance Improvement
  1. Make operational testing **more realistic**, time and **resource constrained**, and **limited in its ability to create additional performance requirements**.
  2. **Create a new category for Initial Operational Test and Evaluation results** that allows Combatant Commanders to accept useful capabilities for deployment which the Director of Operational Test and Evaluation would **otherwise determine to be Not Operationally Effective**.
  3. Require that test planning and criteria development for Operational Test and Evaluation reflect **testing in environments and against the range of threats** that are **identified by the Combatant Commander** -- not by the test community.
  4. Give **Program Managers** explicit **authority to defer non-Key Performance Parameter** related requirements to later acquisition . . .
  5. **Require Joint Requirement Oversight** Council approval of all test plans that require operational testing in environments other than those established in the **Test and Evaluation Master Plan**.

Critical Operational Issues (COI) Rating Definitions

COI Rating	Definition
Fully Mission Capable (FMC) B	Mission can be accomplished in the intended operational environment
Mission Capable (MC) G	Mission can be accomplished, but with increased operational cost
Partially Mission Capable (PMC) Y	Only some aspects of mission can be accomplished *and/or* Mission can only be accomplished under some conditions
Not Mission Capable (NMC) R	Mission cannot be satisfactorily accomplished

COMOPTEVFOR
Perspectives
on
Modeling & Simulation
in
Operational Test & Evaluation

RDML Bill McCarthy

8 March 06

Topics

- Current Trends in Navy Operational Test
    - Integration of Testing (DT/OT)
    - Enterprise Solutions
- Need for Modeling & Simulation
- Policy Considerations
- Challenges – Myths and Money
- The Way Ahead – again!

Current Trends

- Integration of Test and Evaluation
  - Fundamental concept is to minimize the duplication of effort by identifying common data requirements up front.
    - Re-structured MV-22 Program is an example
  - Ongoing effort, formalized in mid-2005 with the development of an Integrated Test Framework
    - Common test, shared data, independent analysis
    - Reduce cycle time and cost for testing while providing earlier operational input
  - Independent OPEVAL is retained to ensure statutory independence of the Operational Test Agency; however, the scope of the OPEVAL can be reduced to the extent that valid data are collected from integrated test.

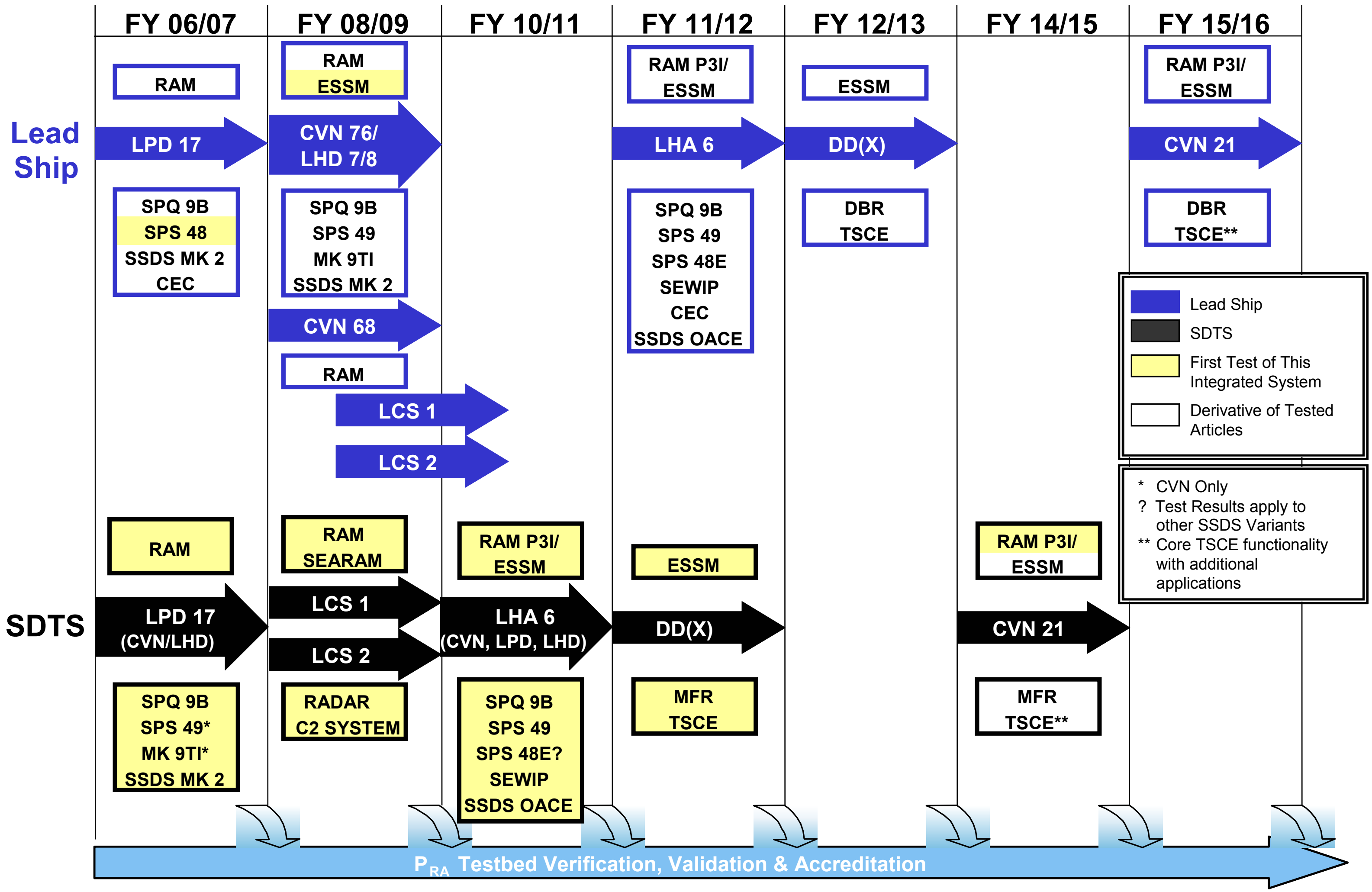
Current Trends

- Enterprise Approaches to Test & Evaluation
  - Should really be titled Enterprise Approaches to Systems Engineering
- Logical consequence of Family of Systems development
  - Ship's Self-Defense System is proto-typical example
    - CVN-76/LPD-17/LHA-6/DD(X)/CVN-78
  - Metric for AAW assessment is Probability of Raid Annihilation
  - LHA-6 test program provided the forcing function
  - Individual testing of the full combat system by each platform would have been prohibitively expensive
  - No single program could bear the cost of a Self-Defense Test Ship

Current Trends

- Alternative approach – realigned development and testing program under PEO IWS
  - By combining test objectives across platforms, conservative estimate is a $200M reduction in missile and target costs
  - Self-Defense Test Ship will allow the acquisition of data to populate the models needed to assess P_{RA}.
- Additional benefits anticipated from increased information sharing across participating platforms

An Enterprise Approach to AAW Self-Defense



Need for Modeling & Simulation in Operational Test and Evaluation

- 21st Century warfare systems are required to operate in complex environments that are difficult to assess
  - AAW performance assessment
    - Need to assess multiple hard and soft-kill systems working together
  - Electronic Warfare systems
    - Realistic pulse densities; unique threat emitters
  - Undersea Warfare systems
    - Multiple environmental conditions; realistic targets

Need for Modeling & Simulation in Operational Test and Evaluation

- Put another way, anything short of actual use in combat is to a greater or lesser extent a form of modeling or simulation.
- We have neither the time nor the money to build large numbers of threat replicators necessary to test the performance of a systems of systems in the diverse environmental conditions that may be encountered.
- The challenge is to find the right mix of M&S and live end-to-end testing to ensure that weapon systems will perform as predicted in actual combat.

DEPARTMENT OF THE NAVY
UNITED STATES OF AMERICA

COMMANDER OPERATIONAL TEST AND EVALUATION FORCE

Policy Considerations

- DODD 5000.1 – "The conduct of test and evaluation, integrated with modeling and simulation, shall facilitate learning, assess technology maturity and interoperability, facilitate integration into fielded forces, and confirm performance against documented capability needs and adversary capabilities…" (E1.11)
- DODI 5000.2 –
  - "The T&E strategy shall provide information about risk and risk mitigation, provide empirical data to validate models and simulations, evaluate technical performance and system maturity, and determine whether systems are operationally effective, suitable, and survivable against the threat in the System Threat Assessment." (E5.1.1)
  - "Appropriate use of accredited models and simulation shall support DT&E, IOT&E, and LFT&E." (E5.1.4.7)

Policy Considerations

- SECNAVINST 5000.2C – "…M&S may be used during T&E of an ACAT program to represent conceptual systems that do not exist and existing systems that cannot be subjected to actual environments because of safety requirements or the limitations of resources and facilities. M&S applications include hardware/software/operator-in-the-loop simulators, land-based test facilities, threat system simulators, C4I systems integration environments/facilities, and other simulations as needed. M&S shall not replace the need for OT&E and will not be the primary evaluation methodology. M&S shall not be the only method of meeting independent OT&E for beyond low rate initial production (BLRIP) decisions per USC 2399. M&S is a valid T&E tool…" (5.4.7.9)

Challenges – Myths and Money

- Perceptions
  - M&S is an inexpensive substitute for testing.
  - M&S is the natural extension of the computer gaming phenomenon.
  - M&S will revolutionize acquisition.
- Facts
  - M&S can provide information about system performance under a variety of conditions that can not be practically assessed with live testing.
  - Development of models is a complex engineering task. Models and simulations vary greatly based upon their purpose.
  - M&S is an essential component in evolutionary acquisition.

The Way Ahead – Again!

- There are few, if any, new ideas needed to make M&S a more effective tool.
  - In the last 8 years there have been a variety of studies, the need is not for study but implementation.
- M&S has played a critical role in the development and operational testing of EW systems for decades.
  - We need to learn from this experience and use the right type of M&S where it best fits.
  - Successful use requires a rigorous understanding what the particular form of M&S can bring to the program.

The Way Ahead – Again!

- M&S must be addressed in the T&E Strategy and the TEMP.
  - The integrated test team needs to determine where various M&S tools are best suited for use.
  - M&S needs to be understood as a tool set, with a variety of different tools, each suited for different applications.
- Program managers must make timely investments to develop the models and collect the data necessary for viable M&S tools.
  - Even when modeling is used, too many programs reach the completion of DT&E without completing the verification and validation of the models used.
- Enterprise solutions require Enterprise level investments in appropriate tools, such as the Self-Defense Test Ship.
  - Without an Enterprise approach, M&S tools are not likely to be available in time to support key acquisition decisions for “systems of systems”.

The Way Ahead – Again!

- Current policies clearly support the use of M&S throughout the entire test and evaluation.
- Rather than new policy, we need to enforce a disciplined systems engineering approach that holds developers accountable for using all available tools to best understand the capabilities and limitations of the weapon system being developed for the warfighter.

Questions?

Challenges For M&S in Army Test and Evaluation

Roe Mirabelle

Chief, Technical Support Division (TSD)

Modeling & Simulation

410-306-0403

Modeling and Simulation in Support of Army Transformation

Quality Control for the US Army

Challenges For M&S in T&E : Outline

- Reality of T&E Transformation
- Getting Your Needs Identified: Plan & Execute
  - Requirements Identification and Decomposition
  - T&E
  - M&S
  - Architecture
  - V&V –and “A”
- Lack Of Success—From Some Experts!
- Challenge to T&E--Make it Better?

ATEC's T&E Mission is Changing

Transformation of Test and Evaluation

Yesterday

Test & Evaluation

System Design Moving Toward

- Greater S/W Based Design
- Technological Improvement
- More Complex FoS and SoS Interactions

Test/simulation & Evaluation

Test/Simulation & Evaluation

Simulation/Test & Evaluation

Tomorrow

Bottom Line:

We'll always test hardware, but are seeing an increased reliance on M&S which will have a more prominent role in our evaluations and increase our need for technical expertise.

Challenge Facing ATEC

Providing fully integrated Test & Simulation Evaluations.

To accomplish that mission ATEC must develop and maintain adequate technical expertise to support the command in the following areas:

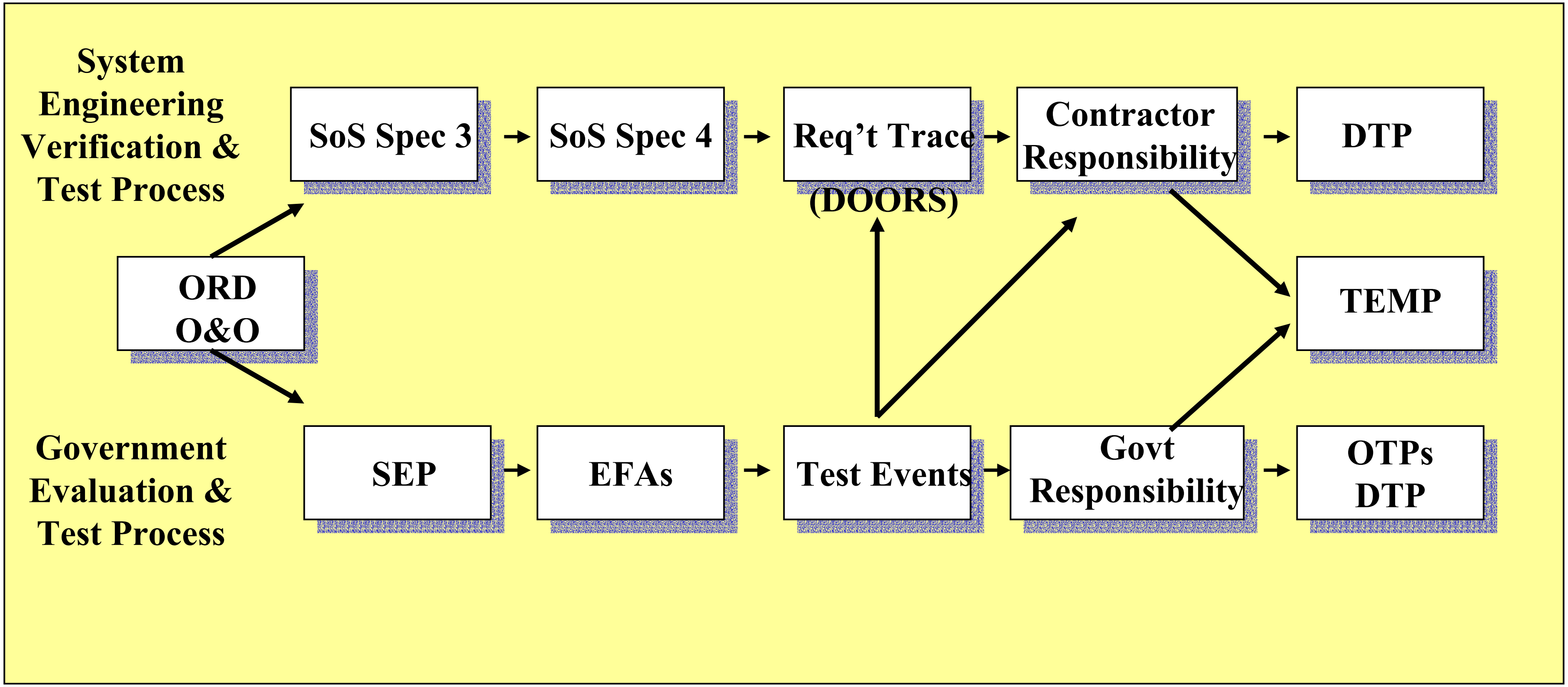
What we evaluate

- **Technology Development – Integrating FoS and SoS technologies and architectures to develop comprehensive evaluation approaches.**

How we evaluate

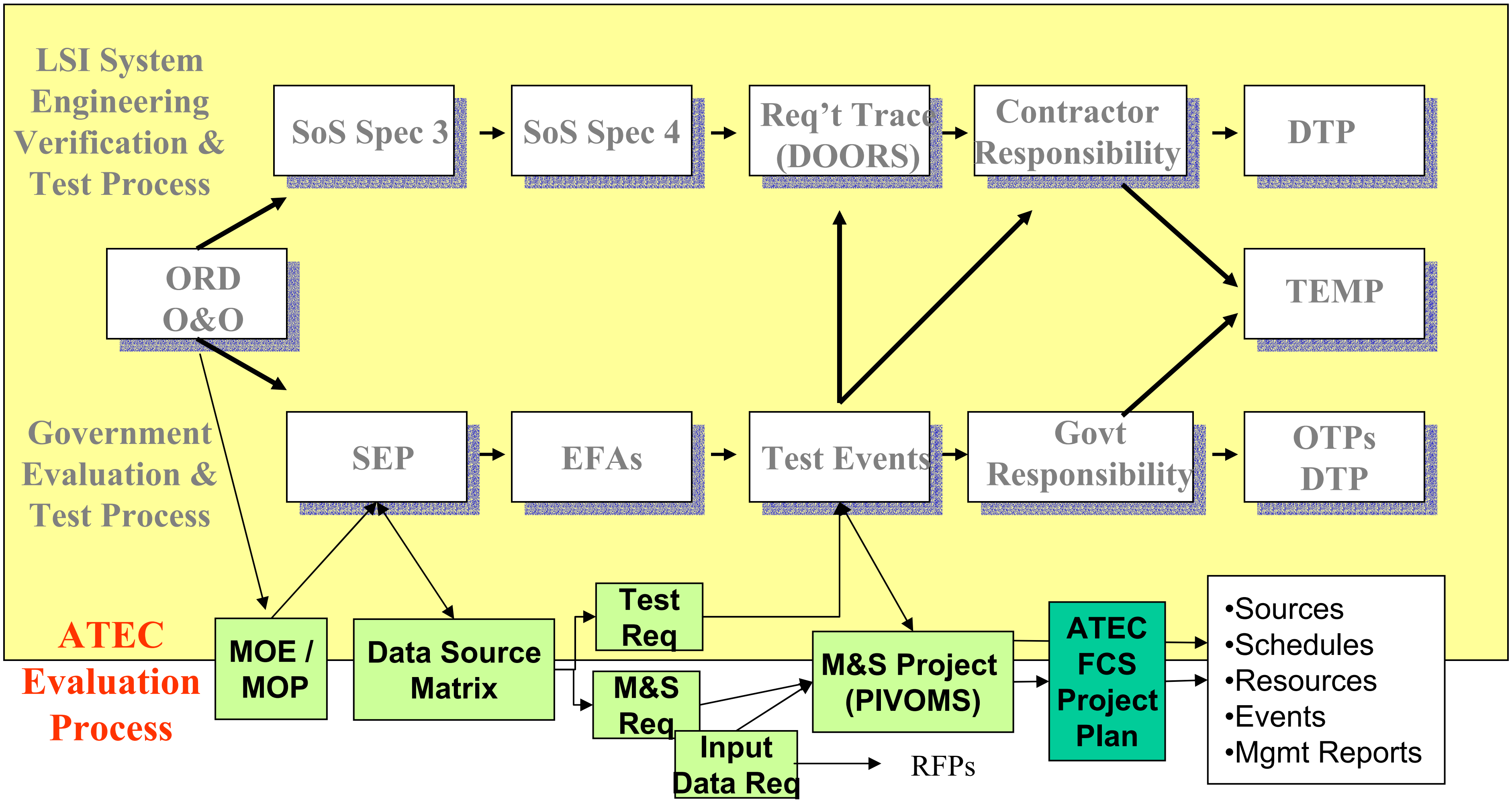
- **Modeling and Simulation – Tracking the development, VV&A of models.**
- **Employing Model-Test-Model to evaluation phases (pretest---test---post test)**
- **Experimental Design – Designing tests that make the most out of expensive hardware testing while taking into consideration how M&S will be used.**

Requirements Planning Process

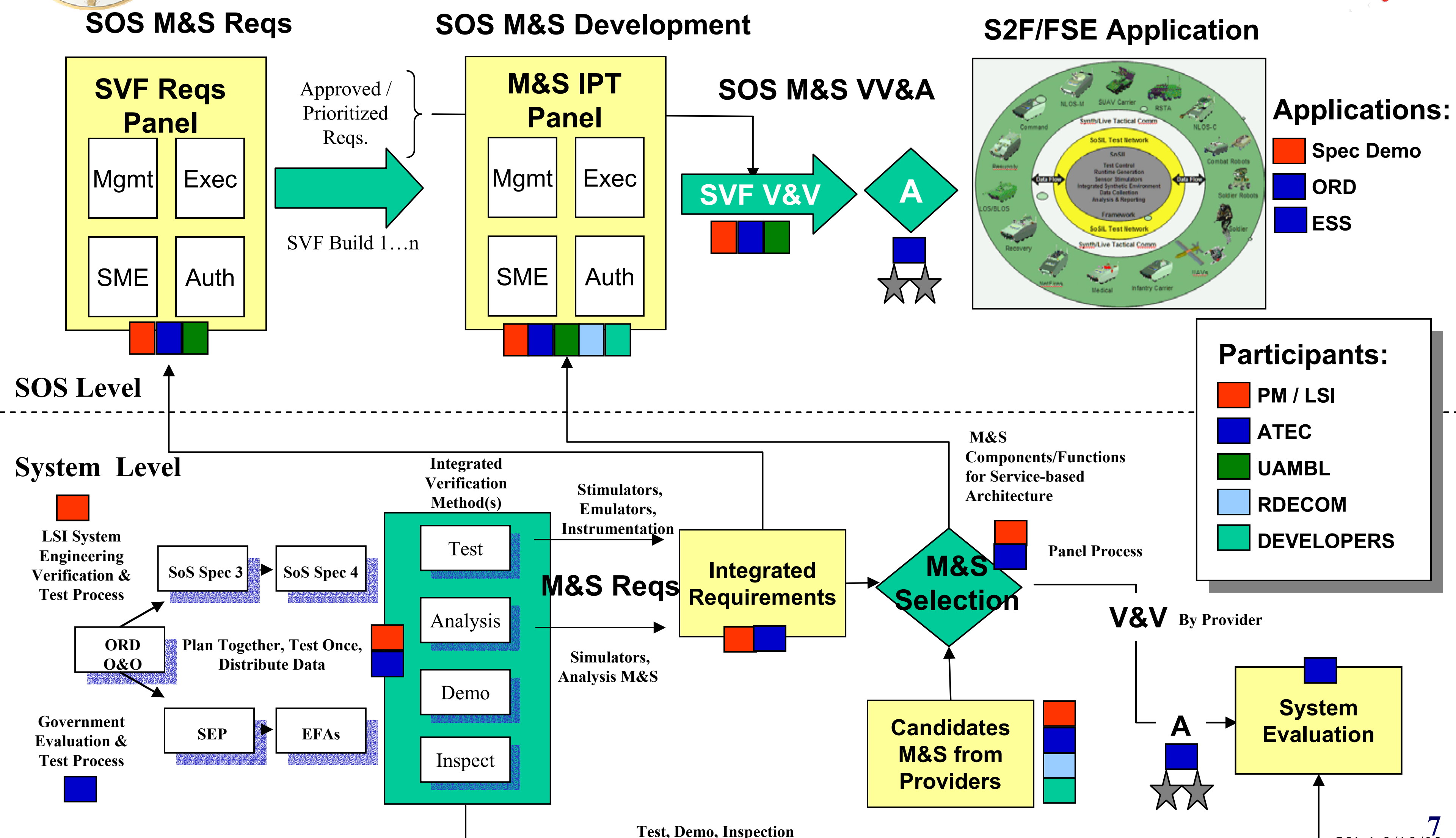


The KEY to being successful is approved requirements ---- driving the evaluation focus areas. If requirements are changing---a ripple effect occurs at every level of the process.

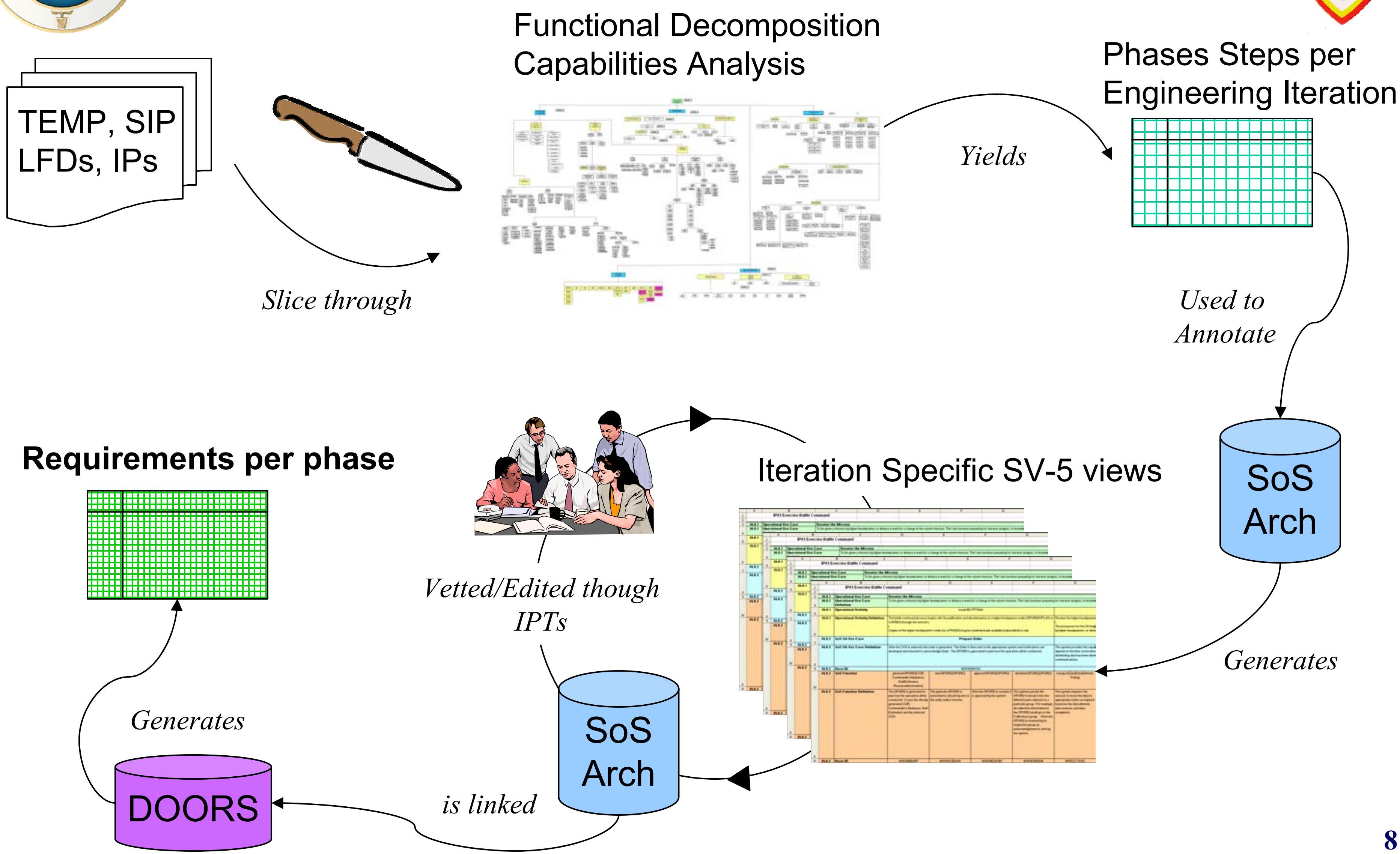
Test & Evaluation Planning Process



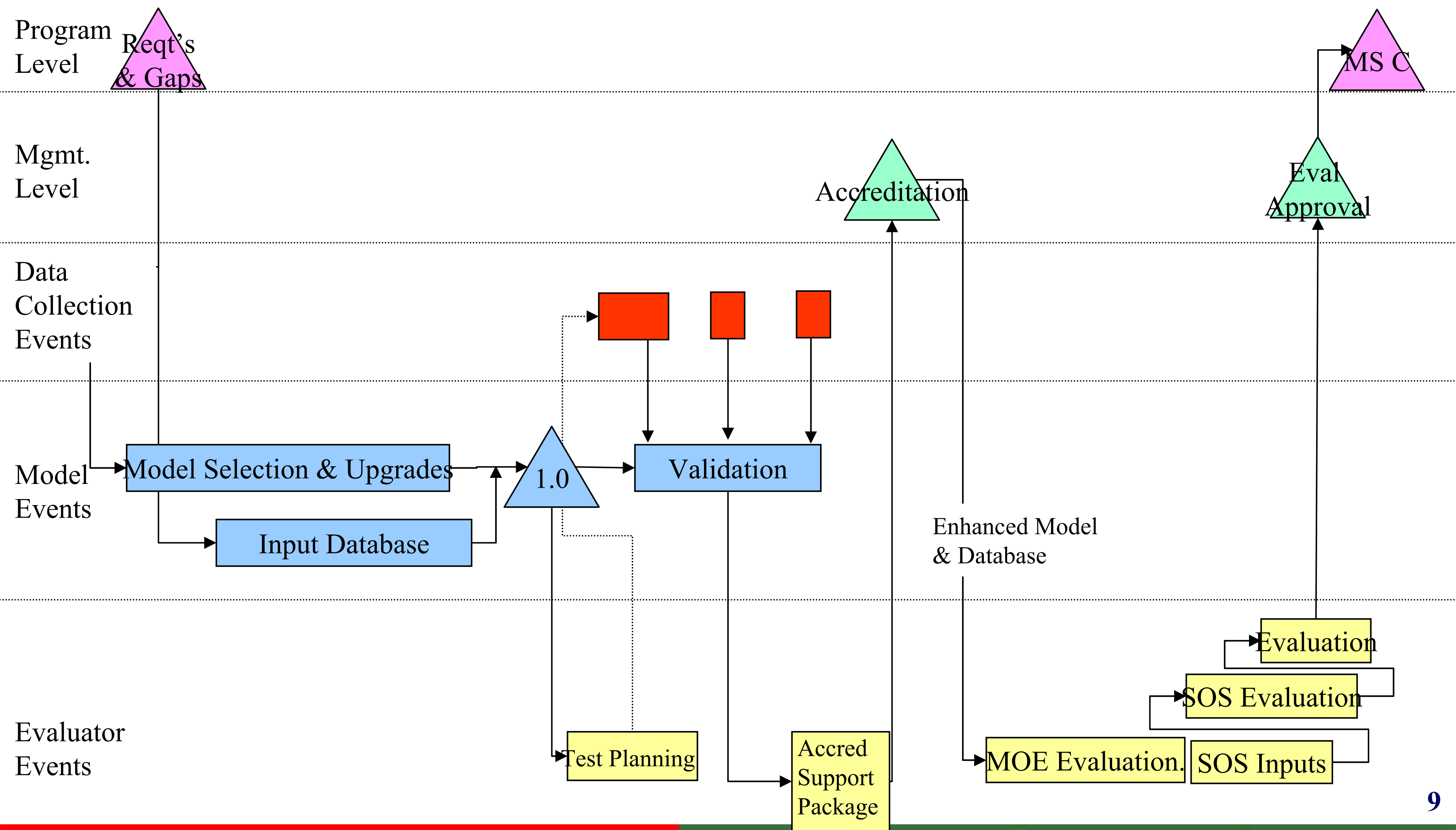
View of M&S Development Process For FCS



Getting M&S Requirements Allocated



The VV&A Process: Lots to Do Over Time



High Level M&S Challenges (1 of 2)

- **Incorporating requirements into tracking and allocation database**.
  - If a requirement is uniquely government, who is responsible for that integration?
  - Is the allocation decomposition completed?

- **Overlap between test execution and development/execution of the next phase**.
  - Is there sufficient time to implement required fixes or apply lessons learned in schedule?

- **Bow wave effect of pushing off M&S requirements to future phases**.
  - How early are M&S (and T&E) requirements needed to be identified?
  - 2 years before execution?
  - Ability to verify and validate (and increase risk) as schedules slip?

High Level M&S Challenges (2 of 2)

- **Changes in plans regarding M&S in test augmentation.**
  - Example: ability to test tactical SW in emulators and collect V&V artifacts

- **Battle Command Simulation Needed? Yes or NO?**
  - Representation of the fully integrated Battle Command capability. Available when? Final delivery of the actual code (Phase 4/Post MS C)?
  - Can incremental deliveries of tactical software integrated into the simulation environment be used? Available?
  - Ability to TEST all of the systems together within a full SoS context. Test articles with C4ISR and full functionality available when?
  - Ability of M&S to represent full FCS BCT. Available when?

- **A V&V Plan—(versus a strategy)-- for M&S tools is required.**
  - Accreditation criteria needed (ATEC Action)
  - V&V Plan needed (PM-Action)

Example of M&S Challenge Affecting Evaluation

- **Demonstrate low risk of KPP completion at Milestone C**
  - FCS BCT consists of three battalions, cannot realize this complexity in actual hardware
  - Virtual and constructive simulation capability critical
- **KPP's Not Possible without the network**
  - Must objectively load the network for results to be credible
  - Data, voice, video, messaging, etc..
- **M&S's critical function is to provide the "wrapper" or stimulus for the objective simulation/software**
  - Must provide an environment from where system and SoS capabilities may be demonstrated
  - Terrain, weather, lethality brokerage, etc…
- **Non-intrusive network simulation and credible aggregate force representations are of the highest priority**
  - Critical to provide "wrap" for the equipment on the range
  - "A Must" to fill out the missing hardware (FCS BCTs/UEx/UEy) in the Experiments and TFTs
- **Non-Intrusive test network for testing at system, FCS BCT, Complementary and Joint systems**

M&S—Not Worked as Often as Liked

- 2003 Academy Industry Symposium on Mathematical Modeling discussed reasons for the lack of success in use of models:
  - Inappropriate method of formulating or representing the problem
  - Ill-conceived multi-disciplinary integration
  - Inability to communicate among multi-disciplinary team members
  - Few existing value/reward systems actually reward collaboration
  - Funding sources not deal well with multi-disciplinary work
  - Isolation of modeling community
  - Difficulty in integrating models of different resolution
  - The practical sociology between modelers and decision makers:
    - Modeling should help/be an aid to critical thinking

EXCERPT FROM: PHALANX Article, Sep 2003: "Issues in Model Integration to Support Decision Makers"; by Dr. Ernest Seglie

M&S
Not Worked as Often as Liked

- 2003 Academy Industry Symposium on Mathematical Modeling discussed reasons for the lack of success in use of models:
  - Inappropriate method of formulating or representing the problem
    - Requirements Identification process cumbersome (Subcontractors, Prime, Engineering, Test, Evaluation)
    - T&E issue is--can we live with less testing? So, we become a user of these products
    - Example: JTRS: supporting development of FCS NW for Current Force and Future Force
      - Modeling while development ongoing. Objectives are?
      - Is transport layer for FCS; yet architecture definition evolving.
      - Planned integrated approach through PM M&S team, but harder to say what we can bank on
  - Ill-conceived multi-disciplinary integration
    - So many systems + Network; Modeling and development ongoing simultaneously
    - Have SOS to address; Who has done this before—at a level of required fidelity?
    - Inability to communicate among multi-disciplinary team members
      - Players: Subs + LSI + ATEC + Evaluation (SEP) + PM + CTO + PM M&S (MSMO) + Training
      - T&E challenge to program is: Communicating requirements for this SOS M&S to this hugh crowd – to include JOINT---with varying crowd experience-NOT EASY!
    - What does program integrator know about how ARMY does SOS testing? Evaluation?

EXCERPT FROM: PHALANX, Sep 2003: “Issues in Model Integration to Support Decision Makers”; by Dr. Ernest Seglie

M&S
Not Worked as Often as Liked (continued)

- 2003 Academy Industry Symposium on Mathematical Modeling discussed reasons for the lack of success in use of models:

  - Few existing value/reward systems actually reward collaboration
    - Stove pipe development; scramble for dollars to develop products; parochial views
  - Funding sources not deal well with multi-disciplinary work
    - Program dollar cuts; is sudden at times.
    - Other priorities evolve and take over
    - SW development—costly and difficult
  - Isolation of modeling community
    - What IS out there that can provide best insights into effectiveness, suitability, survivability?
  - Difficulty in integrating models of different resolution
    - Major integration effort on this program; multiple BOS systems
  - The practical sociology between modelers and decision makers:
    - Modeling should help/be an aid to critical thinking…

EXCERPT FROM: PHALANX, Sep 2003: “Issues in Model Integration to Support Decision Makers”; by Dr. Ernest Seglie

Challenge to T&E--Can We Make it Better? Summary

- **Encourage programs to integrate modeling into their development and decision process.**

- **Integrate into T&E evaluation ONLY IF modeling has demonstrated it is an integral part of the program processes and demonstrates it is an aid to critical thinking.**
  - Multi-disciplinary team established, in place, and functioning to add information to contractors, PM, and evaluators. Needed 7-10 years before IOT.
  - Feedback loop working through cycle on early component testing and early operational assessments.
  - M&S developed in sufficient resolution so that test planning parameters can be, and are, calculated using the model.

EXCERPT FROM: PHALANX Article, Sep 2003: "Issues in Model Integration to Support Decision Makers"; by Dr. Ernest Seglie

Conclusion:
Simply the place where someone got tired of thinking.
Great Quotes From Great Skeptics

- **Well informed people know it is impossible to transmit the voice over wires and that were it possible to do so, the thing would be of no practical value.** ***Editorial in the Boston Post (1865)***
- **That the automobile has practically reached the limit of its development is suggested by the fact that during the past year no improvements of a radical nature have been introduced.**
  Scientific American, Jan. 2, 1909
- **Heavier-than-air flying machines are impossible.**
  Lord Kelvin, ca. 1895, British mathematician and physicist
- **While theoretically and technically television may be feasible, commercially and financially I consider it an impossibility, a development of which we need waste little time dreaming.**
  - Lee DeForest, 1926 (American radio pioneer)
- **There is not the slightest indication that [nuclear energy] will ever be obtainable. It would mean that the atom would have to be shattered at will.** ***Albert Einstein, 1932.***
- **Where a calculator on the ENIAC is equipped with 19,000 vacuum tubes and weighs 30 tons, computers in the future may have only 1,000 vacuum tubes and perhaps only weigh 1.5 tons.**
  Popular Mechanics, March 1949. **(Try the laptop version!)**

~~28~~ 27 Steps to Success:
The DoD Acquisition M&S Master Plan

22nd Annual National Test & Evaluation Conference

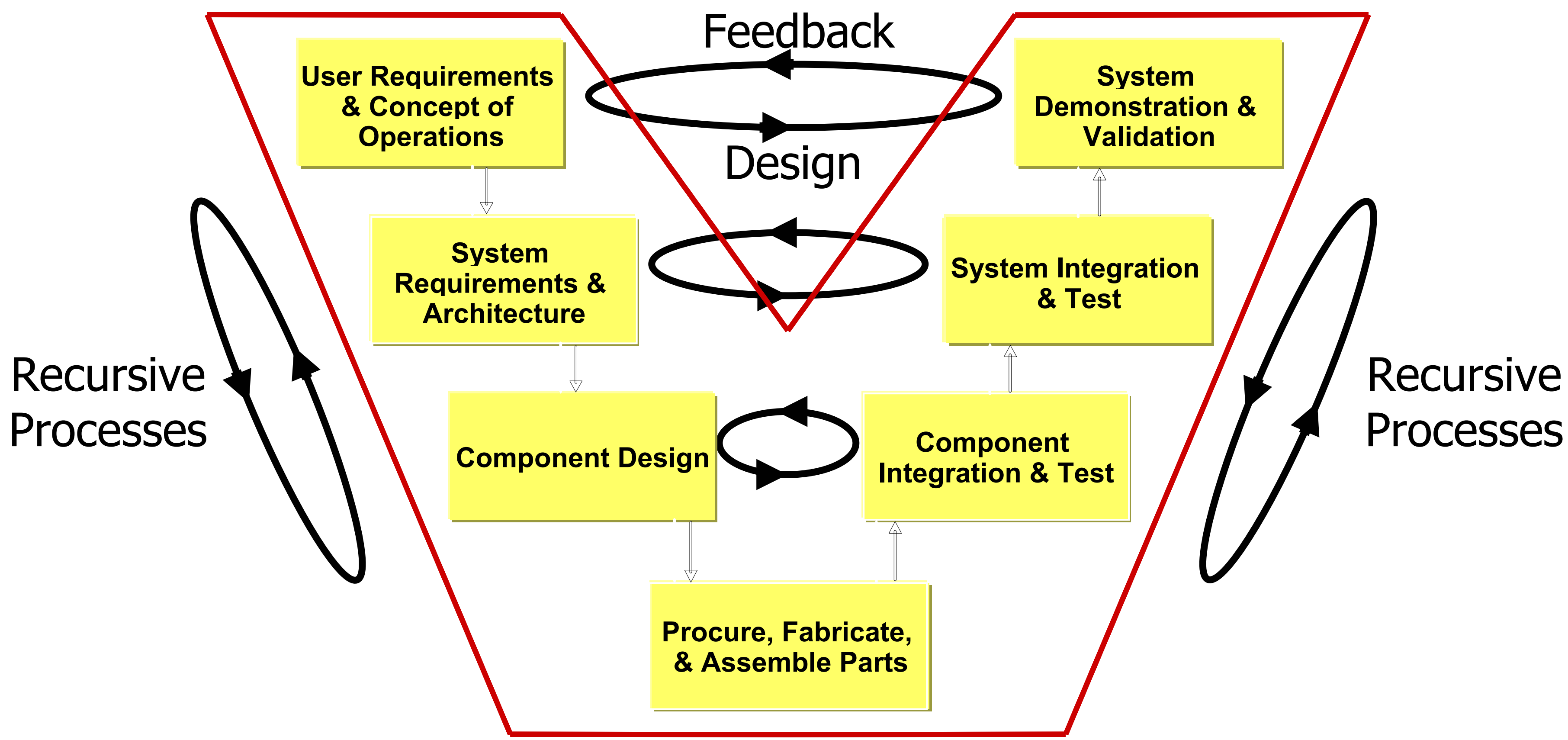
Fred Myers, OUSD (AT&L) DS/SE

Chair, Acquisition M&S Working Group

March 9, 2006

M&S is a Necessary Part of Acquisition

M&S is broadly useful to enable systems engineering throughout a system or S-o-S life cycle



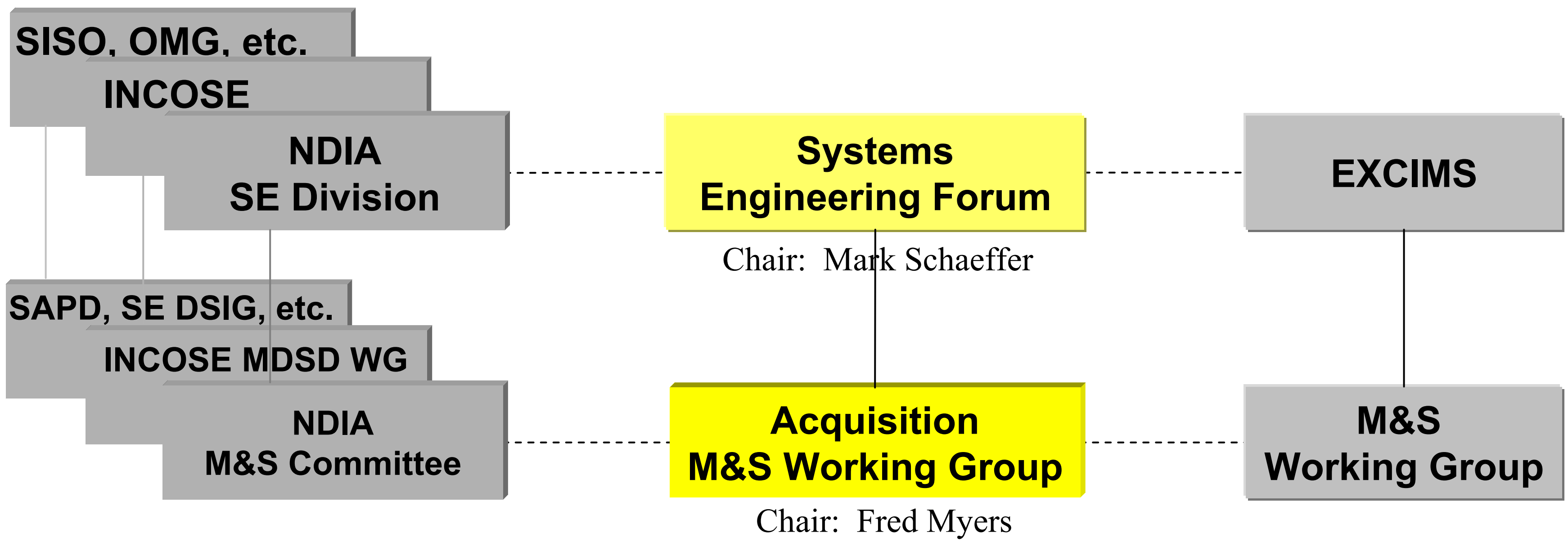
"Help drive good systems engineering practices back into the way we do business."
Under Secretary of Defense for Acquisition, Technology and Logistics

Acquisition M&S Working Group

Established by SE Forum Feb 2005, to define a plan to solve the problems

…anchored in acquisition community, linked to industry and M&S

Industry / Academia | **DoD SE** | **DoD M&S**



Products

Reports (e.g., "M&S Support to the New DoD Acq. Process"), standards, papers, etc.

Product

Acquisition M&S Master Plan

Product

DoDI to Implement DoDD 5134.01

A Sampling of DoD's M&S Problems

- Minimal reuse of M&S & data; hard to discover reusable resources; insufficient info to evaluate reuse candidates; no incentives to re-use
- No contractual guidelines for M&S and data needs
- No DoD requirement for formal M&S planning to support acquisition
- Lack of agreed standards for interchanging information
- No conceptual framework for data interchange
- Many M&S tool gaps and deficiencies
- M&S developers - not M&S users - tend to drive M&S development
- No readily-available L-V-C distributed environment
- VV&A often weak or non-existent; documentation inconsistent
- No business model for developing, using, maintaining M&S capabilities
- Acquisition community managers (and staffs) are mostly uninformed about M&S capabilities and limitations
- Body of knowledge for M&S support to acquisition is deficient, not managed

Acquisition M&S Master Plan Development Process

- Bottoms Up:
  - Assessed recommendations from prior studies on M&S in Acquisition
  - Assessed current issues and needs (today's SoS efforts)
- Top Down (Desired Acquisition Environment):
  - DoDD 5000.1
  - CJCSI 3170.01
- Identified gaps to better enable Acquisition M&S
- Identified actions to address the gaps for Acquisition M&S
- Identified actions of others (e.g., DMSO, NII, Services)
- Documented actions, lead organizations, and completion dates in the draft Acquisition M&S Master Plan

27 Steps to Success

- 27 Needed Actions
- Each Action
  - Rationale (Why is it needed?)
  - Discussion (What is the specific action?)
  - Lead & Supporting Organizations (Who is involved?)
  - Products (What is the product?)
  - Completion Goal [year] (When will the action be completed?)
- Execution Management

5 Acquisition M&S Objectives; 27 Actions

Objective 1

Provide necessary policy and guidance

Actions

1. M&S management
2. Model-based systems engineering & collaborative environments
3. M&S in testing
4. M&S planning documentation
5. RFP & contract language
6. Security certification

Objective 2

Enhance the technical framework for M&S

Actions

7. Product development metamodel
8. Commercial SE standards
9. Distributed simulation standards
10. DoDAF utility
    - DoDAF 2.0 Acqn Overlay
    - Standards for depiction & interchange
11. Metadata template for reusable resources

Objective 3

Improve model and simulation capabilities

Actions

12. Acquisition inputs to DoD M&S priorities
13. Best practices for model/sim development
14. Distributed LVC environments
    - Standards
    - Sim/lab/range compliance
    - Event services
15. Central funding of high-priority, broadly-needed models & sims
    - Prioritized needs
    - Pilot projects
    - Expansion as warranted

Objective 4

Improve model and simulation use

Actions

16. Help defining M&S strategy
17. M&S planning & employment best practices
18. Foster reuse
    - Business model
    - Responsibilities
    - Resource discovery
19. Info availability
    - Scenarios
    - Systems
    - Threats
    - Environment
20. VV&A
    - Documentation
    - Risk-based
    - Examination
21. COTS SE tools
22. M&S metrics

Objective 5

Shape the workforce

Actions

23. Definition of required M&S competencies
24. Harvesting of commercial M&S lessons
25. Assemble Body of Knowledge for Acqn M&S
26. M&S education & training
    - DAU, DAG & on-line CLMs
    - Conferences, workshops & assist visits
27. MSIAC utility

5 Acquisition M&S Objectives; 27 Actions

(14 actions broader than acquisition)

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Provide necessary policy and guidance

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1. M&S management
2. Model-based systems engineering & collaborative environments
3. M&S in testing
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27. MSIAC utility

Key

Broader than Acquisition

5 Acquisition M&S Objectives; 27 Actions

(10 actions applicable to T&E)

Objective 1

Provide necessary policy and guidance

Actions

1. **M&S management**
2. **Model-based systems engineering & collaborative environments**
3. **M&S in testing**
4. **M&S planning documentation**
5. **RFP & contract language**
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Enhance the technical framework for M&S

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    - **DoDAF 2.0 Acqn Overlay**
    - **Standards for depiction & interchange**
11. **Metadata template for reusable resources**

Objective 3

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    - **Pilot projects**
    - **Expansion as warranted**

Objective 4

Improve model and simulation use

Actions

16. **Help defining M&S strategy**
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    - **Responsibilities**
    - **Resource discovery**
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Key

Broader than Acquisition

T&E Special Interest

Summary of Actions and Products of Interest to the T&E Community

- Establish policy and guidance:
  - To require documented M&S planning as part of the:
    - Systems Engineering Plan
    - T&E Strategy and
    - T&E Master Plan
  - For security certification of M&S activities falling under multiple Designated Accreditation Authorities (DAA)

Products: Revised policy and guidance in DoDI 5000.2, 8500.2; DAG; & TEMP Planning Guidance

Summary of Actions and Products of Interest to the T&E Community (cont.)

- Foster cost-effective VV&A
  - Develop risk-based methodology and associated guidelines for VV&A expenditures
  - Require DoD-wide standardized documentation of VV&A
  - Examine a program's VV&A when M&S informs major acquisition decisions and unambiguously state the purpose, key assumptions and significant limitations of each model/simulation when results are presented.

Products: Updated DoDI 5000.61; revised policy and guidance in DoDI 5000.2 & DAG; Guidance & training for oversight personnel

Summary of Actions and Products of Interest to the T&E Community (cont.)

- Enable readily-available distributed live-virtual-constructive environments
  - Examine opportunities to converge distributed simulation standards (HLA, DIS, TENA, …)
  - Establish DoD-wide standards for distributed environments
  - Foster compliance by candidate simulations, labs, and ranges

Products: A larger collection of simulations, labs, & ranges ready to be employed in distributed events

Summary of Actions and Products of Interest to the T&E Community (cont.)

- Educate and train the workforce to achieve required M&S competencies
  - Provide M&S knowledge via an expanded set of DAU courses, the DAG, and on-line CLMs
  - Provide VV&A training for oversight personnel

Products:

- Expanded set of DAU courses
- Improved M&S guidance in the Defense Acquisition Guide
- On-line Continuous Learning Modules
  - "M&S in SE"
  - "M&S in T&E"

Current Status and Way Ahead

- Completed coordination of Draft Acquisition M&S Master Plan at both the working and senior levels
- Formal DoD coordination pending outcome of Department level M&S management deliberations
- Re-chartering the AMSWG with new responsibilities:
  - Monitor and assist with AMSMP execution
  - Define and implement a process to identify and prioritize M&S needs/projects that serve a broad set of acquisition users
  - Advocate Acquisition M&S needs and recommendations at the DoD corporate level
  - Assess the state of acquisition M&S, relevant new technology, and new M&S initiatives
  - Interface with Industry to align DoD and Industry approaches for M&S

Questions / Discussion ?

Using the Missions and Means Framework to Generate Cost-Effective Live-Fire Test and Evaluation Strategies

22nd Annual National Test & Evaluation Conference
Jacksonville, Florida

9 March 2006

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Introduction

Live-fire testing (Joint Live Fire and Title 10 LFT&E) is now in its third decade.

Contributions of LFT&E

- Identification and verification of system and munition design strengths and weaknesses
- Quantification of crew hazards from the spectrum of insults
- Motivation of verification & validation (V&V) of system-level analytical models

Key to success: Identification of critical evaluation issues — significant design and deployment concerns — on which to focus testing and analysis

Issues Addressed

- Are current Live-Fire Test & Evaluation (LFT&E) processes relevant and useful in light of current changes in:
  - war-fighting?
  - system designs?
  - integrated information-centric battlefield?
  - extended mission timelines?
- What changes are needed in LFT&E strategies to address the role of the tested platform in the context of a collection of assets available to the unit commander to prosecute a wide range of complex missions?

Issues Addressed

- Considering risk, cost, availability of hardware, and production schedule, how can LFT&E programs be constructed to ensure decision-makers are provided with data in a format that allows them to ascertain the likelihood of completing system of system (SoS) collective tasks?
- How does the Missions and Means Framework (MMF) provide a foundation for the development of cost-effective LFT&E strategies and programs?
- What issues must be addressed in the implementation of the proposed MMF-based SoS task-focused approach to LFT&E?

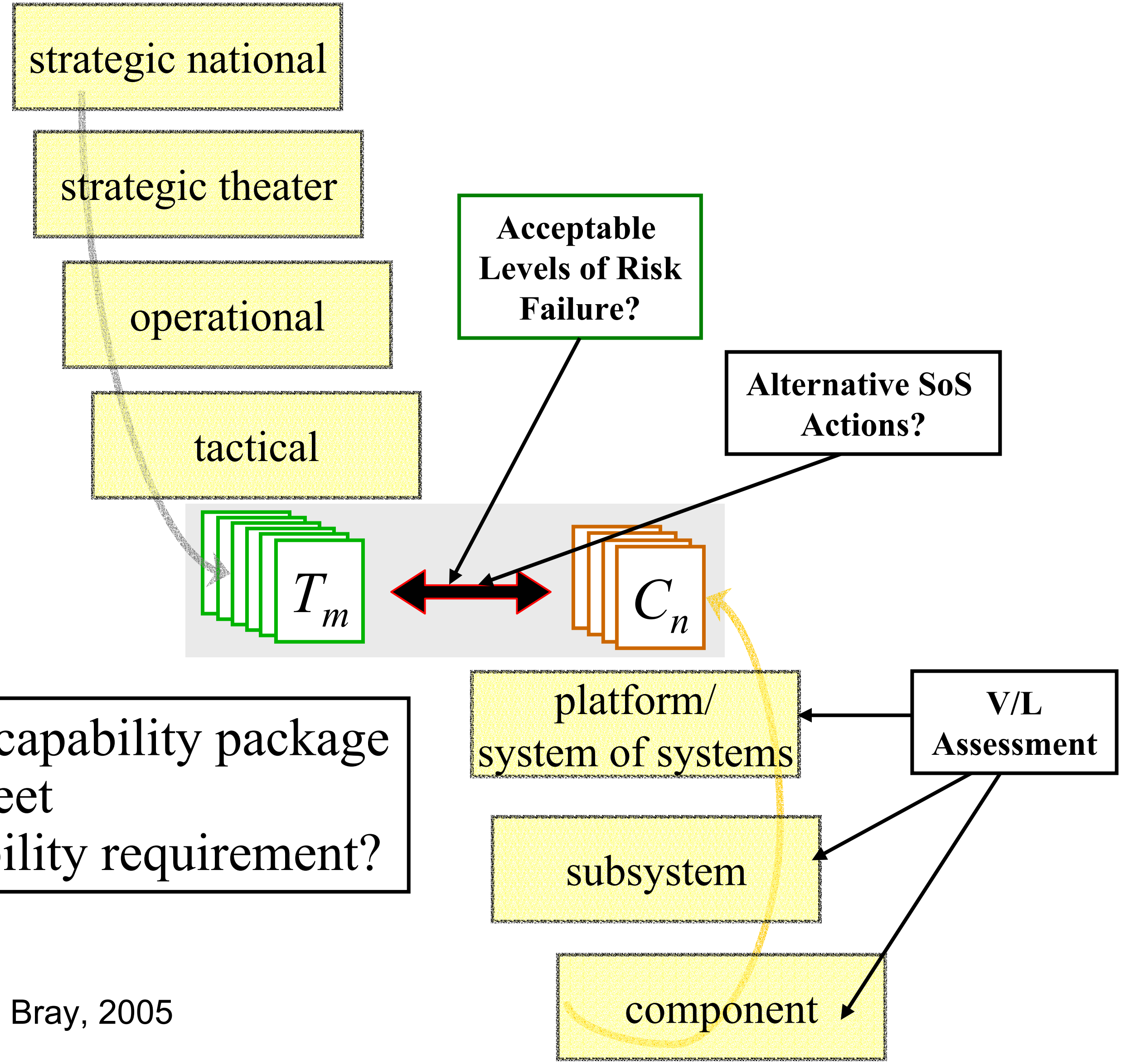
Objective of Test and Evaluation

Assess capabilities of SoS platforms, individually and collectively, to complete identified tasks in tactically realistic scenarios

Understanding of Hardware Hierarchy that Induces Capabilities

Understanding of Mission Hierarchy that Induces
Tasks
Standards
Conditions

Assessing Capabilities Against Mission/Task Requirements



Does the mission capability package meet
the mission capability requirement?

Modified from Tanenbaum, Bray, 2005

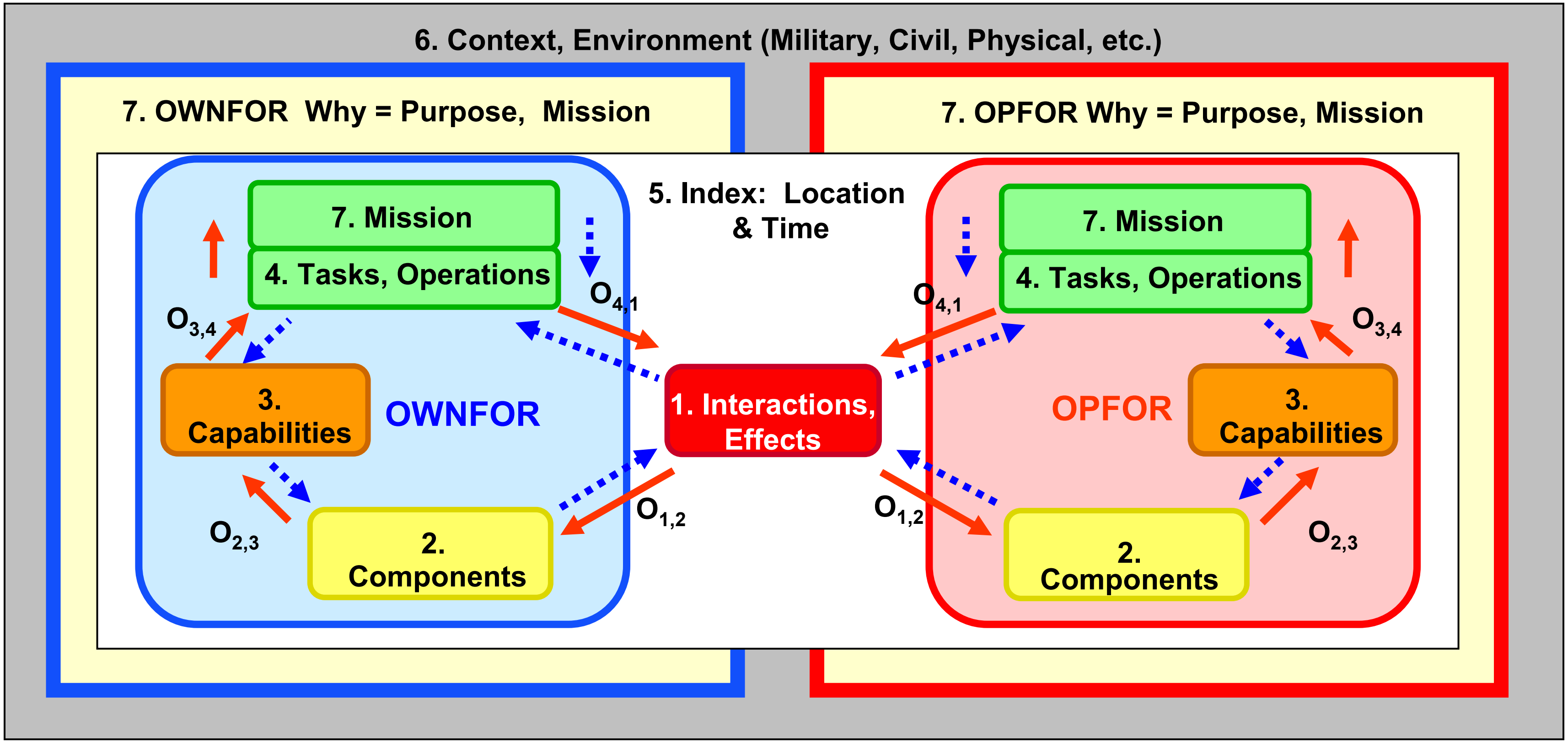
Objectives of an Effective LFT&E Program

An effective vulnerability LFT&E program in an SoS environment provides data that allow evaluators to assess:

- The extent to which the platform retains those capabilities determined to be needed for completion of SoS tasks, when the system interacts with the full spectrum of ballistic threats likely to be encountered in combat.

- The extent to which the SoS is able to complete the identified mission tasks in the joint environment, given the residual and available (as determined in LFT&E) capabilities of the tested platform.

Missions and Means Framework: Foundation for Cost-Effective LFT&E



The MMF provides the foundation for developing cost-effective LFT&E strategies by establishing the links among mission tasks, platform capabilities, platform components, and interactions of ballistic threats and tested platform.

Modified from Sheehan, et al., 2004

Critical Issues – Keys to LFT&E Success

- To evaluate armor platform vulnerability solely through FUSL testing, tens of thousands of FUSL tests would be required.

  - Example for armor platform:
    - -- 10+ threat classes (small arms, mines, etc; several variants in each)
    - -- 8+ attack directions per threat
    - -- 500+ impact points per attack direction …
    - ➔ easily over 40,000 firings

  - Fortunately we don't rely only on testing; many combinations can easily be eliminated.
    - -- Inspection and engineering judgment
    - -- Analysis
    - -- Etc.

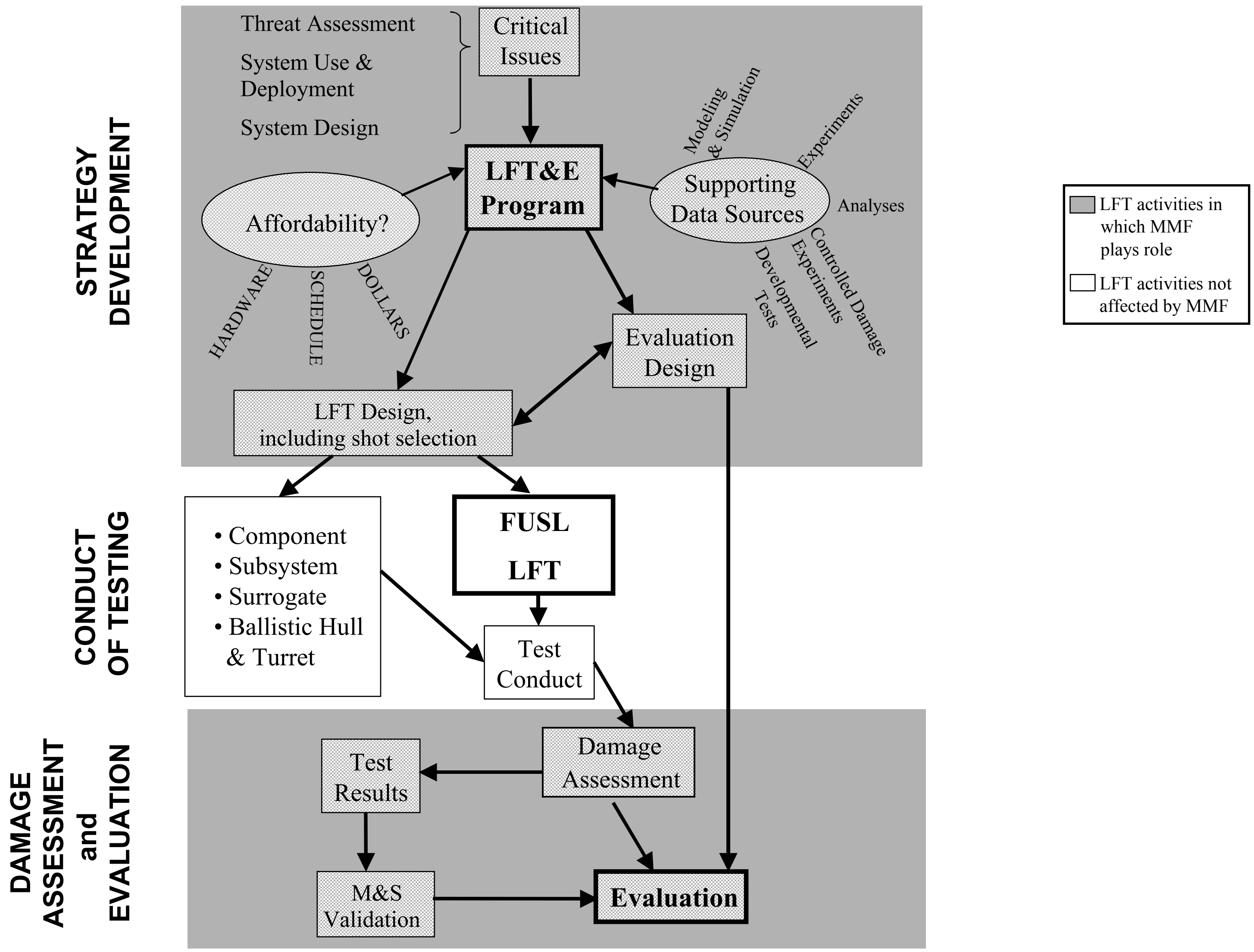
  - Even if 90% can be easily eliminated, several thousand possible firings remain.

- A typical FUSL LFT can afford 10 – 20 firings.

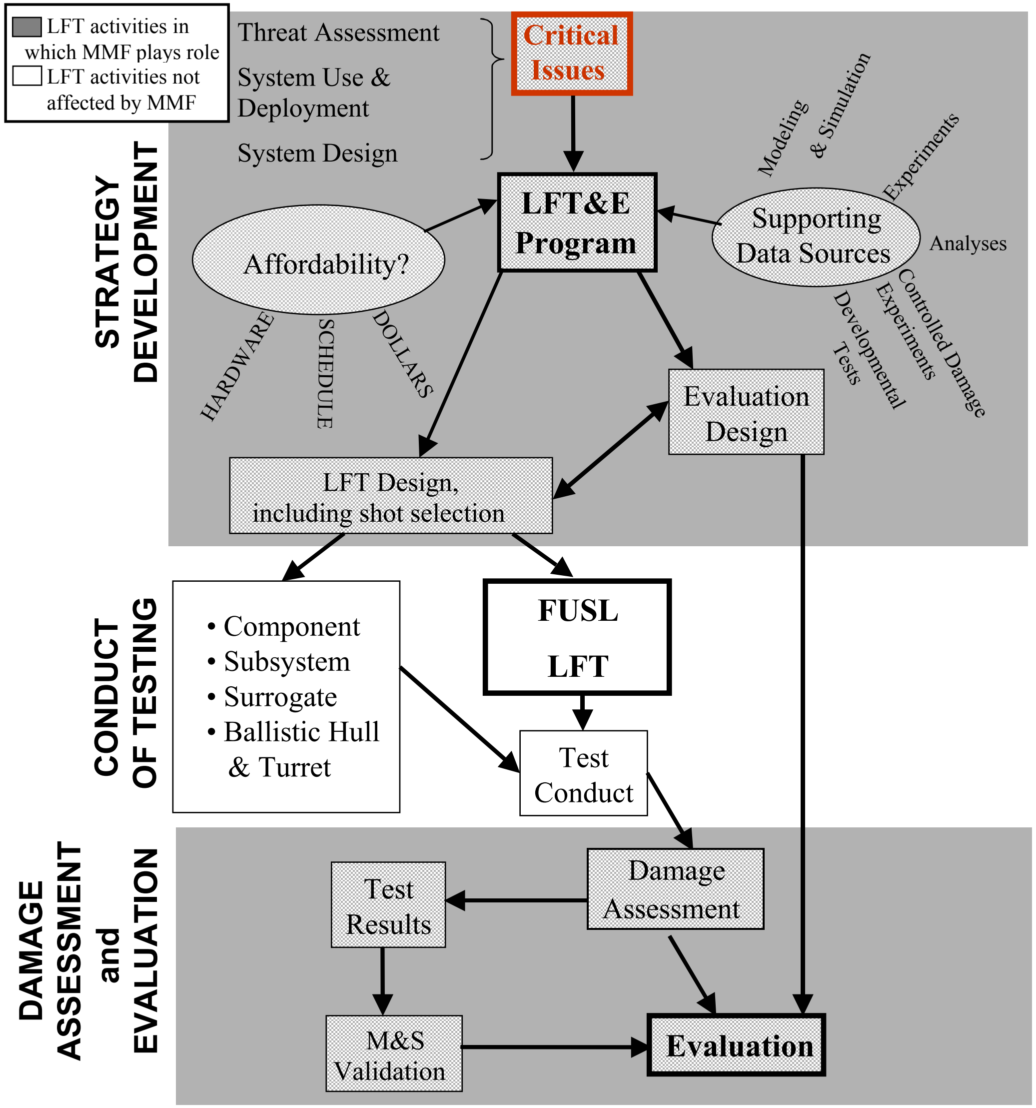
  - Critical issues in LFT&E strategy specify rationale for which 10 or 20 shots of the possible thousands will be most productive.
    - -- Define critical evaluation issues, i.e., questions to be answered through FUSL LFT.
    - -- Determine how supplementary data can be combined with FUSL results.

MMF provides basis for rational cost-effective strategy.

Influence of MMF on LFT&E Process



Differences Between Platform-Centric and MMF Task-Focused Strategies - Critical Issues –



Critical Issues

Platform-centric strategy

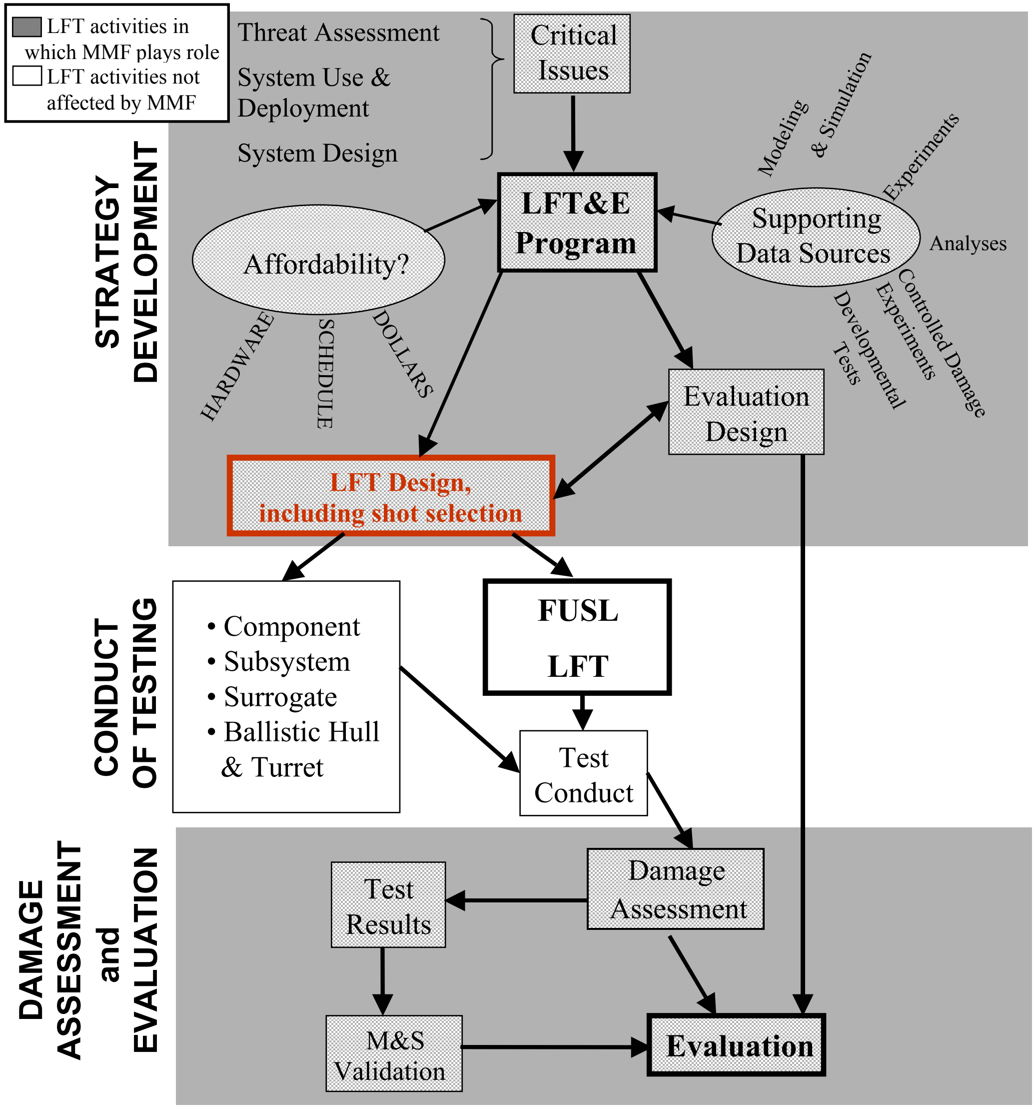
1. **Vulnerability of the platform**?
2. Remaining **platform mission utility**?
3. Role of BDAR in restoring **platform functional capability**?

MMF-based SoS task-focused strategy

1. **Reduction in the ability of the SoS to prosecute typical missions**?
2. Remaining **platform capabilities**?
3. Role of BDAR **and other maintenance actions in restoring SoS capabilities critical to mission prosecution**?

[With both strategies, causes and effects of crew injury are usually critical sub-issues.]

Differences Between Platform-Centric and MMF Task-Focused Strategies
- Shotline Selection –



Shotline Selection

Platform-centric strategy

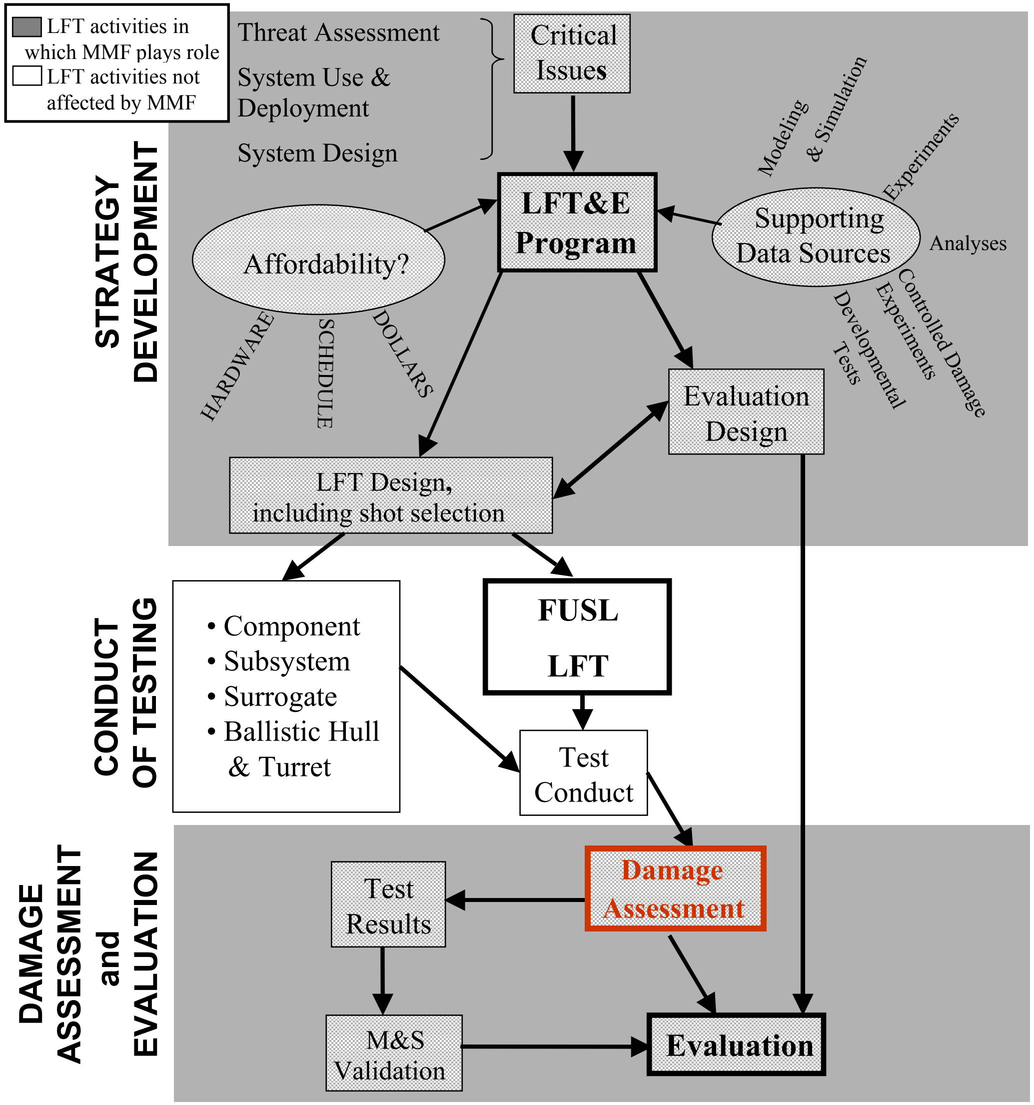
Shotlines are selected on basis of technical risk associated with inability to determine **platform capability**.

MMF-based SoS task-focused strategy

Shots are selected on basis of technical risk associated with inability to determine **effect on mission prosecution caused by loss of platform capabilities**.

(With both strategies, shots against crew are selected on basis of technical risk associated with ability to predict injury to crew and passengers.)

Differences Between Platform-Centric and MMF Task-Focused LFT&E Strategies - Damage Assessment –



Damage Assessment

Platform-centric strategy

Platform: Map subsystem loss of function to **combat utility via $O_{3,4}$ mapping construct**

Battle Damage Assessment and Repair: Expedient repairs to restore platform **to some level of combat utility**

MMF-based SoS task-focused strategy

Platform: Map subsystem loss of function to **SoS capabilities by analysis and operational-type tests**

Mission Damage Assessment and Repair:
- BDAR: Expedient repairs to restore **some platform capabilities immediately following an engagement**
- **Other maintenance procedures to anticipate future mission engagements**

(With both strategies, crew and passenger casualties are assessed.)

Building a Cost-Effective LFT&E Program

Consideration of Budgetary Constraints

Cost-Effective LFT&E Program

Identification of critical issues to be addressed in elements of LFT&E program

Prioritization of data voids and the design of LFT (including shot selection) to address the prioritized data voids

Design & execution of the evaluation process, in which results of LFT & other program-supporting activities are considered

Foundation: Missions and Means Framework

Cost-Effective LFT&E: Assessing Vulnerability Risk

Likelihood that a significant vulnerability (personnel casualties, catastrophic loss of system, failure to complete mission tasks) will remain undetected in a fielded platform

Inherent Risk	Control Risk	Detection Risk
Operating environment: susceptibility of system to significant system & personnel vulnerabilities	Survivability/ vulnerability program activities of project manager office (PMO)/contractor: risk that significant vulnerability will not be prevented during the design & production phases of system	Activities performed by sources independent of PMO/contractor: risk that significant vulnerability will not be discovered prior to fielding

Cost-Effective LFT&E: Weighing Costs of Vulnerability Assessment

CONTROL COSTS

- **PREVENTION**
- **APPRAISAL/ DETECTION**

$

FAILURE TO CONTROL COSTS

- **INTERNAL FAILURES**
  - •RE-DESIGN
  - •RE-ENGINEERING
  - •RETROFIT
- **EXTERNAL FAILURES**
  - SYSTEM LOSS
  - PERSONNEL CASUALTIES
  - FAILURE TO COMPLETE TASKS/ MISSIONS

Cost-Effective LFT&E Programs: Assumptions

- Decomposition of relevant missions into lower-level tasks will have been completed.

Missions

to accomplish

comprise

Tasks

- A relationship between lower-level tasks and the minimum levels of system capabilities needed to complete those tasks will have been established.

Tasks

to perform

enabled by

Capabilities

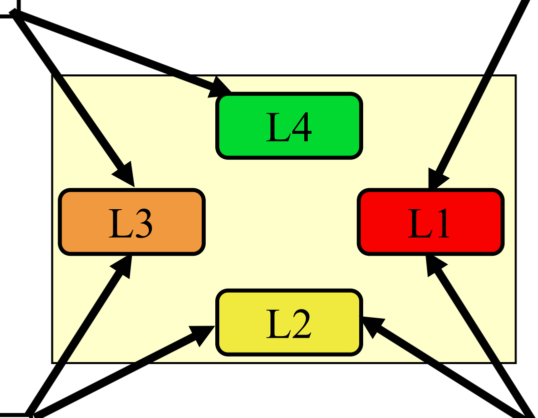
- The platforms and SoSs that provide the capabilities to complete the tasks will have been identified; redundancies and interdependencies between platforms are known.

Operational Requirements capture required capabilities.

Cost-Effective LFT&E: Identify Data Required to Assess Vulnerability in Ballistic Interactions

Links **($O_{3,4}$)** between levels of capabilities required of platform to complete tasks (Level 3)
<u>and</u>
specific mission tasks of identified combat scenarios (Level 4)

Platform-threat interactions (**L1**)



Links **($O_{2,3}$)** between damage state vectors (Level 2)
<u>and</u>
capability state vectors (Level 3)

Links **($O_{1,2}$)** between platform-threat interactions (Level 1)
<u>and</u>
damage state vectors (Level 2)

Cost-Effective LFT&E: Sources for Required Data

- Results of material, component, subsystem, & system-level tests of:
  - -earlier models or current model of system
  - -earlier or contemporary models of systems with similar technologies
- Design analyses with consideration to new materials/technologies
- Combat data relevant to damage mechanisms, system damage, and residual capabilities of system as associated with the identified threats
- Advanced technology and concept technology demonstrations
- Force development tests/experiments
- Warfighting experiments
- Engineering analyses and controlled damage experiments
- Modeling and simulation runs that incorporate system description, threat characteristics, and damage-mechanisms expected in threat-system interactions
- Failure Modes, Effects, and Criticality Analyses
- Results of developmental, operational, and production qualification tests

Cost-Effective LFT&E: Building Program

Identify available and reliable data.
Identify data voids.

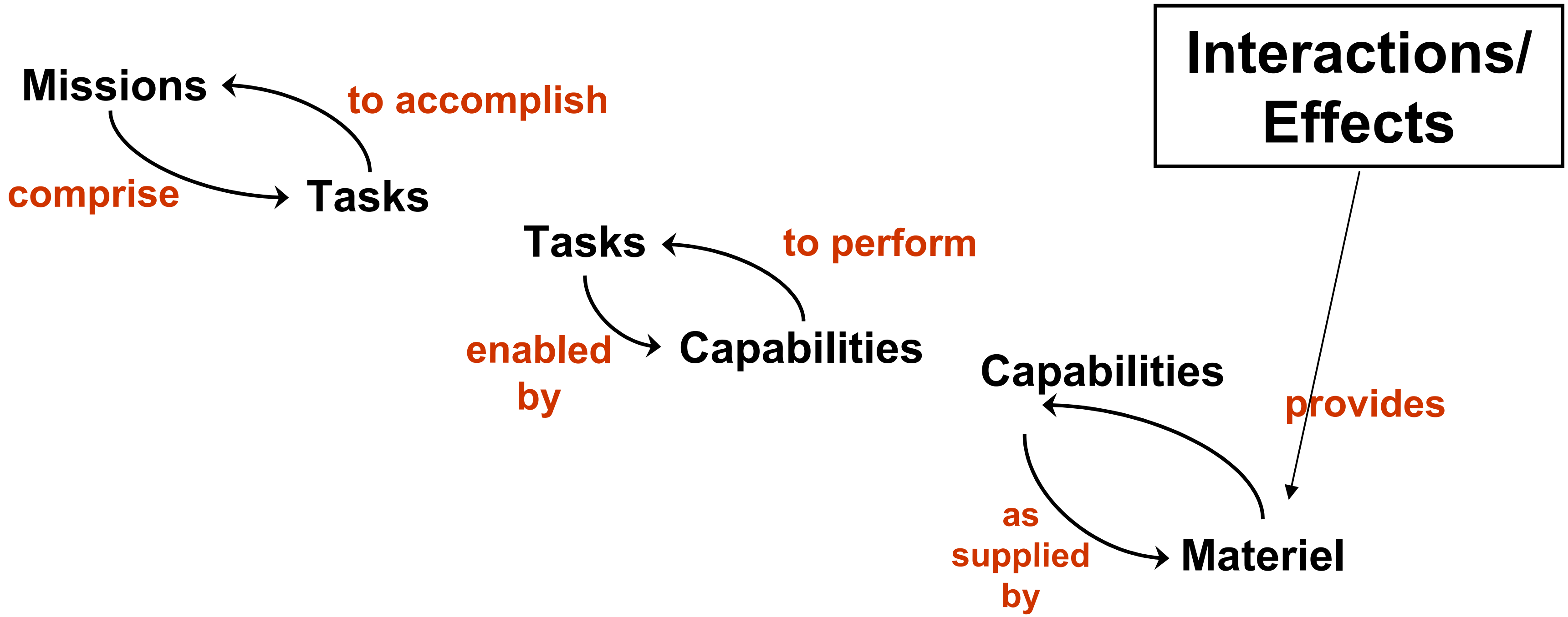
Prioritize data voids (use experts with domain-specific experience, Analytic Hierarchy Process, Quality Function Deployment, etc.).

Identify alternative elements in a LFT program to fill data voids and select from among those elements.

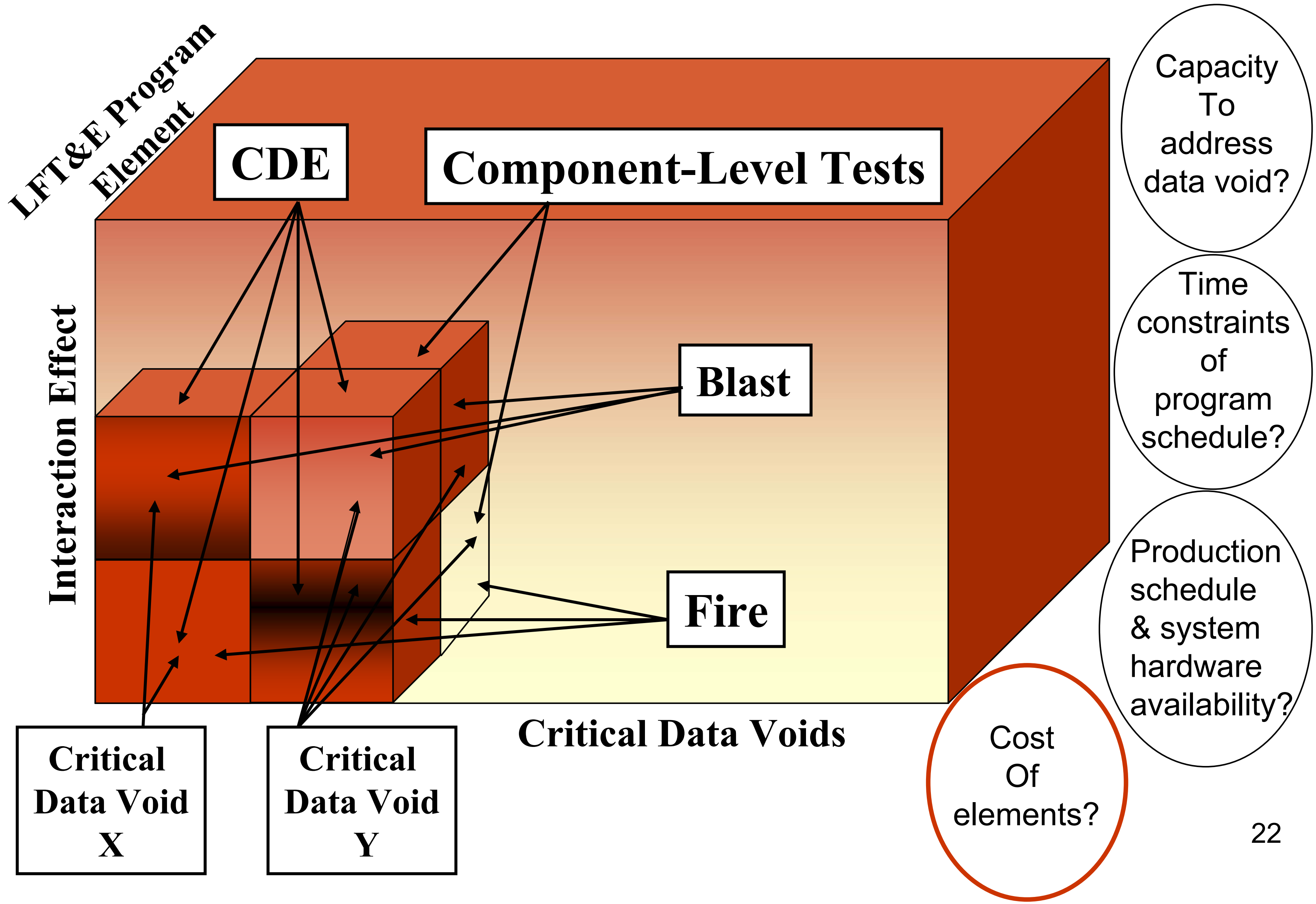
Consider data priorities, element performance, costs, & risks.

Contribution of MMF to Planning for LFT and Evaluation of Results

The ability and inability to obtain reliable data pertaining to specific data voids have consequences for specific mission tasks, as shown through the links of:



Cost-Effective LFT&E: Building Program



Cost-Effective LFT&E: Measuring Costs of FUSL LFT&E Element

- Identify the activities and sub-activities of the LFT program elements for which costs are to be measured.
- Apply activity-based costing (ABC) methodology to measure costs of activities/sub-activities of elements and assist decision-makers in addressing questions:
  - are we doing the right things? adding value?
  - are we doing things right? working efficiently?

FULL-UP SYSTEM-LEVEL LFT&E

PLANNING

M&S

PERFORMANCE

DOCUMENTATION

EVALUATION

$ MODEL EXTENSION/ EXPANSION

$ MODEL V&V

$ PRE-SHOT PREDICTIONS

$ RERUNS OF PRE-SHOT PREDICTIONS

$ FULL-VIEW V/L ESTIMATE

Cost-Effective LFT&E: Measuring Costs of FUSL LFT&E Element

Applying ABC: Identify the direct material costs and the costs of resources used in cross-functional activities of the LFT program element.

DIRECT MATERIALS	COST OF ACTIVITIES
Test Articles	Planning
Spare Parts	M&S
Munitions	Test Performance
Targets	Documentation
	Evaluation

Cost-Effective LFT&E: Cost Complexities

- Costs of elements of vulnerability assessment are:
  - incurred by a multiple number of players.
  - reimbursed from a multiple number of sources.

- Methodologies for measuring and reporting costs across systems/divisions/Services are not uniform.

- Cost database with uniform accounting principles is not currently available for purposes of cost management/ control and/or projection of future costs:
  - to afford consistency across time periods.
  - to afford comparability across systems/Services.

Cost-Effective LFT&E: Cost Database Requirements

- Identify specific data to be collected and reported.
- Identify methods for the measurement of costs, including the allocation of costs.
- Identify procedures for disclosure of cost measurement/allocation methods if alternative methods are available.
- Identify format for reporting costs (e.g., level of cost aggregation).
- Identify procedure for handling missing and incomplete data.

Cost-Effective LFT&E: Implementation Issues

To implement a cost-effective MMF-based SoS task-focused approach to LFT&E, need:

- Integration under the MMF of the efforts of acquisition, requirements, M&S, T&E, and training communities, achieved only through the support of top levels of defense administration

- Allocation of resources to appropriate Service divisions to ensure availability of test assets, including hardware, testing facilities/ranges, and people with the levels of expertise needed for the planning and evaluation processes

Cost-Effective LFT&E: Implementation Issues

To implement a cost-effective MMF-based SoS task-focused approach to LFT&E need:

- Construction of platform operational requirements based on the capabilities needed for the completion of multiple tasks of multiple missions
- Identification and measurement of costs of LFT&E elements according to a consistent methodology to allow a weighing of costs against the value added in conducting individual program elements

“No More Second Opinions: Organizing DoD M&S Within the Acquisition Cycle”

by

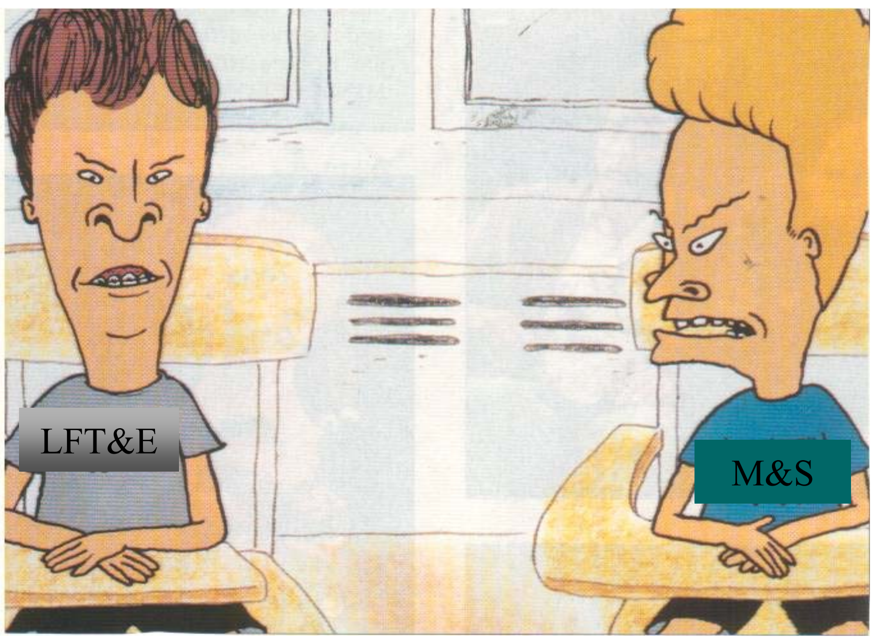
James F. O’Bryon

The O’Bryon Group

443-528-2711

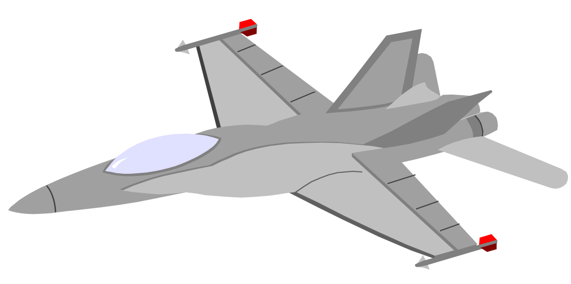
NDIA T&E Conference,
Jacksonville, FL
March 9, 2006

M&S AND T&E ARE PARTNERS, NOT COMPETITORS



MODELING AND SIMULATION
IN
TEST & EVALUATION

Modeling and simulation are an integral part of T&E and not to be looked at as a substitute, nor a means to save money. M&S and testing are mutually supportive and none is complete without the other.



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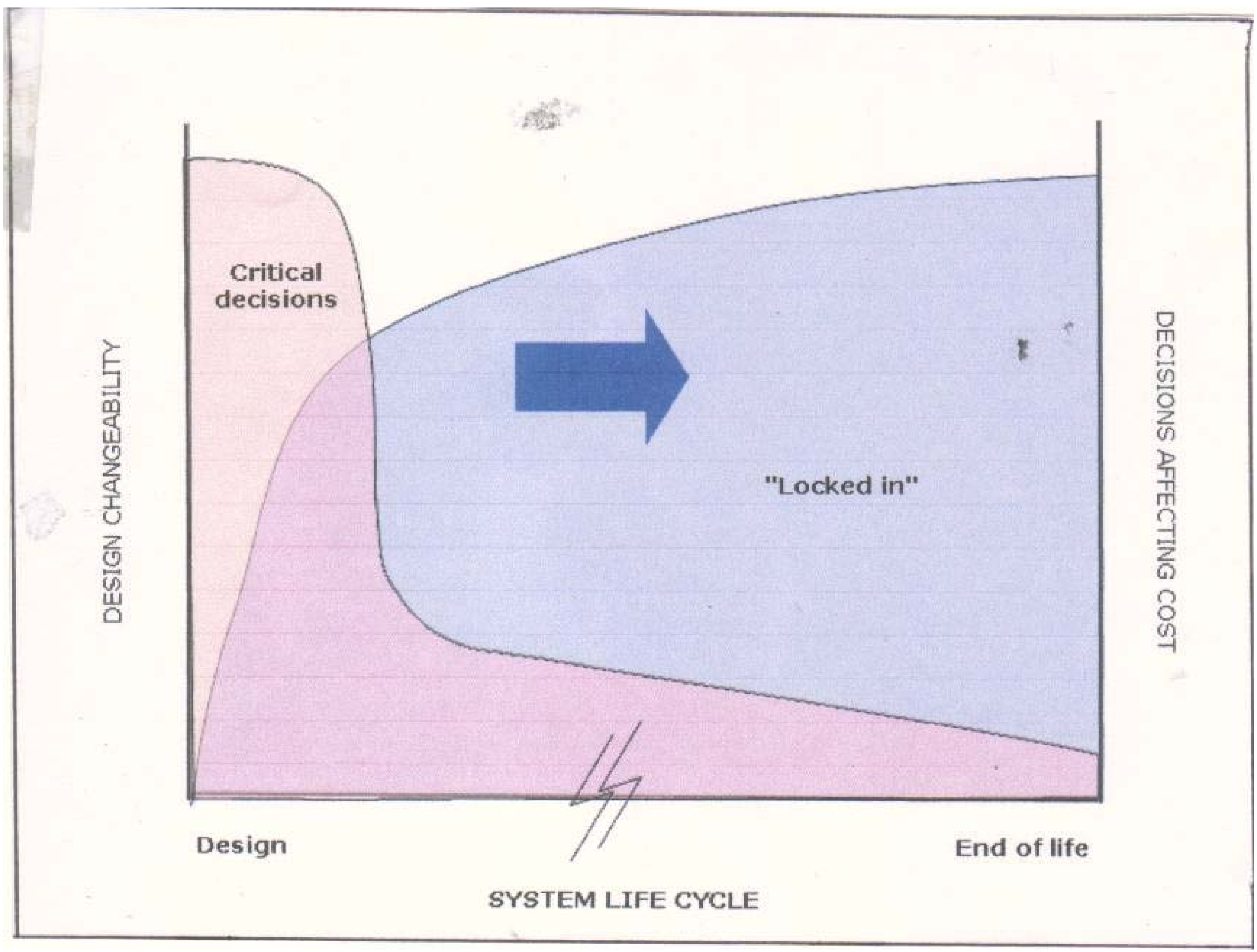
M & S PLAY A VITAL ROLE EARLY ON IN SYSTEM DESIGN AND VERIFICATION

Source: R. Garrett, "Opportunities in Modeling and simulation to Enable Dramatic Improvements in Ordnance Design, "presented to the Committee on Bridging Design and Manufacturing. National Research Council, Washington, DC., April 29, 2003.



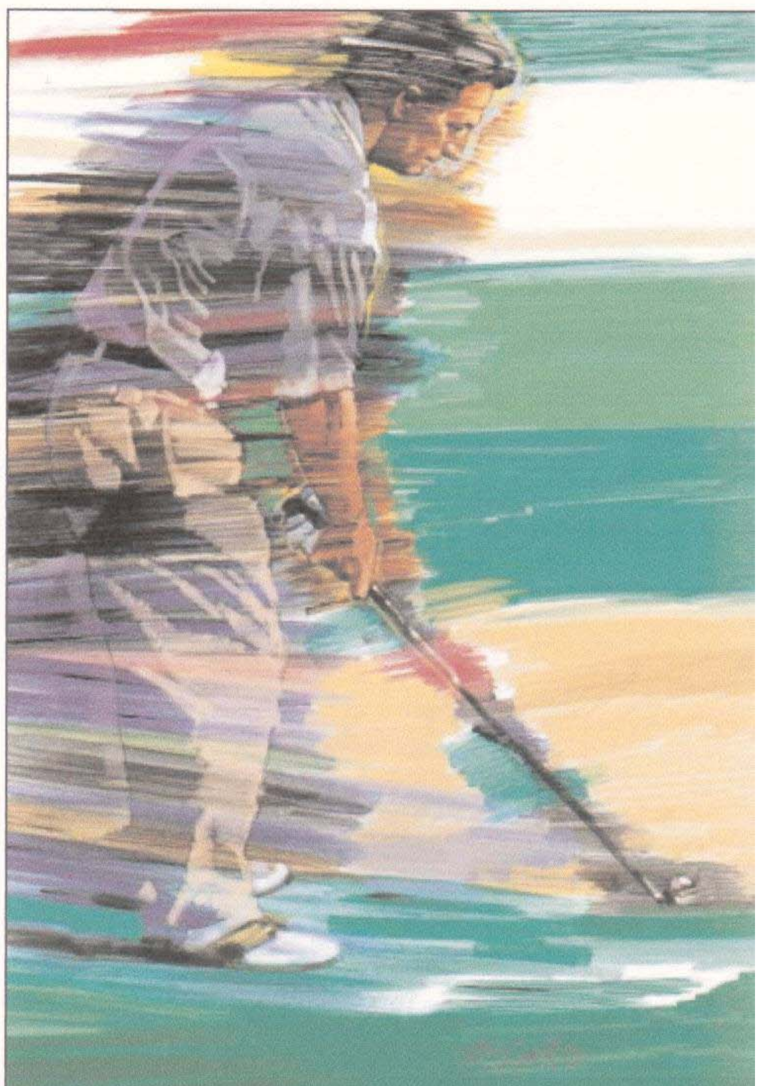
A Proposal That Might Work:

Program Manager Magazine

Meet "MASTER"—Modeling & Simulation Test & Evaluation Reform

Energizing the M&S Support Structure

JAMES F. O'BRYON



In the following few pages, I discuss my personal thoughts on an issue of paramount importance not only to the Department of Defense, but also to the nation's defense. My hope is that this article will provoke serious thought and meaningful action to resolve the issues raised.

First, A Look Back

Since arriving in the Pentagon just over 12 years ago, and for more than a decade before that serving as a weapons analyst in the Department of Defense (DoD) infrastructure away from the Washington area, I have been witness to numerous and surprisingly similar technical and management discussions about the need to get the modeling and simulation capabilities of the DoD organized, incentivized, under control, and more efficient to better serve the weapons development and acquisition process.

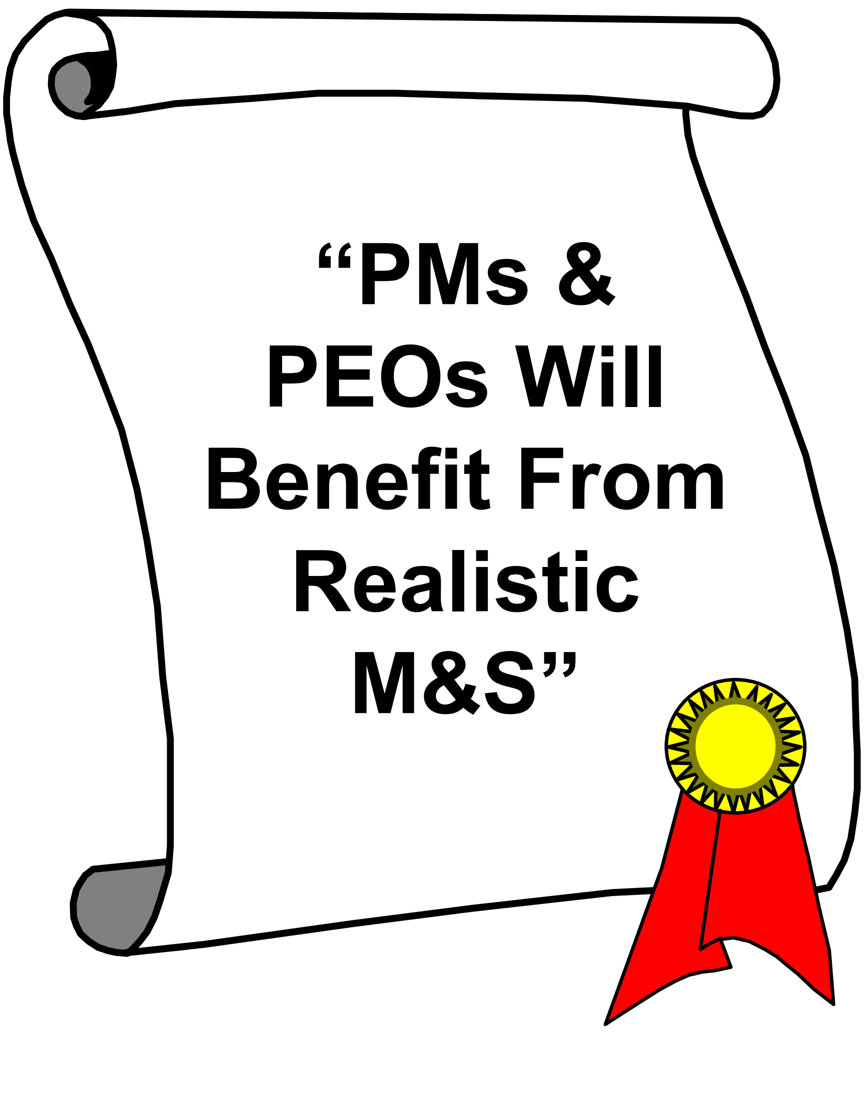
These discussions included such issues as a common and meaningful model architecture, model inter-connectivity, language consistency, validation, model proliferation, and configuration control. They've also covered the problems of duplication, modeling "stovepipes," the lack of meaningful and up-to-date documentation supporting M&S, and of course, the lack of model realism.

O'Bryon serves as the Deputy Director, Operational Test and Evaluation, Live Fire Testing, in the Office of the Secretary of Defense, The Pentagon, Washington, D.C. His undergraduate degree is in Mathematics, and he also holds two graduate degrees: one in Operations Research from The George Washington University, and another through the Electrical Engineering Department of the Massachusetts Institute of Technology.

TRUTH # 1

TRUTH # 2

TRUTH # 3



TRUTH # 4


"PMs Have
Short Time
Horizons
And, Hence,
On Their
Investment
Decisions"

TRUTH # 5


"Realistic M&S Is Not Necessarily Viewed As A Benefit By The PM"

TRUTH # 6

What's Needed?

"MASTER"

MODELING **A**ND
SIMULATION **T**EST AND
EVALUATION **R**EFORM

What is 'MASTER'?

- **MASTER is a <u>management approach</u> to modeling and simulation in support to the defense department's policy of simulation-based acquisition**
- **It will provide**
  - **<u>critical-mass funding</u>**
  - **add <u>discipline</u> to the development of modeling and simulation**
  - **assure that funds expended on modeling and simulation are spent to <u>further *the state of the art*,</u> including VV&A**
  - **add <u>connectivity</u> across various model vectors being developed**
  - **<u>free up the Program Manager's time & concerns</u> about modeling and simulation support**
  - **assure the most <u>realistic models & simulations</u> are exercised in designing testing, evaluating, training, fielding and fighting our systems.**

Consortium Discussion

Program Managers would initially describe their system(s), acquisition strategy, and M&S requirements to a consortium which would then parse out these needs into vectors of M&S technical responsibility.

Consortium Members, who are charged with having knowledge of *state of the art*, as well as where it exists within and outside of their respective organizations, would make the decisions as to which M&S tools best suit the PM's needs and where the funds would be expended to meet the specific requirements of each Program Manager's system(s). They would upgrade extant models where available and originate M&S only when absolutely necessary. In many instances, these investments would be allocated to organizations external to the Consortium Membership itself.

Must Have Up-Front Investment in M&S!!

"I expect programs to make the **up-front** investment in modeling and simulation application technology, and will be looking for evidence of that investment in program planning and execution."

Honorable Jacques S. Gansler, Under Secretary of Defense (Acquisition and Technology) 1998

If there’s no new money, where will the money come from to fund this “MASTER” initiative?

Where Would Money to Fund the Consortium Come From?

A modest tax ("greens fee") would be assessed upon every Program Manager's total budget. These funds would be placed in the Consortium's account to provide the needed M&S support to the Program Manager.

The proposed "tax" would be a percentage of the Program Manager's budget (perhaps 2-3%). This is significantly less than what is currently spent by PM's on a plethora of isolated M&S activities.

The tax would <u>not</u> be at the discretion of the Program. It would be a policy decision and implemented early on at the OSD Comptroller level.

Funds would be removed early to:

- **enable sufficient time to develop the needed M&S, and,**
- **avoid the tendency to cut the funding of modeling and testing programs, when problems arise and budgets get tight**

Potential Modeling Vectors Needed for the Testing and Training Communities

SOME EXAMPLES:

TERRAIN
WEATHER
CADCAM SYSTEM DESCR
AERODYNAMIC FLOW/FLIGHT
STABILITY
6 DOF FLY-OUT
TARGET SIGNATURES
SENSOR/FUZING
SMOKE/OBSCURATION
C3I
EW
ACOUSTIC
BALLISTIC
1-1 ENGAGEMENT
MxN ENGAGEMENT
VULNERABILITY
LOGISTICS
MANY OTHERS

What are Some of the Benefits of Forming a Consortium to Oversee M&S Investment Within the DoD?

1. It would assure that Program Managers have the best and most realistic model support for their programs.
2. It would establish the necessary consortium protocols for model architecture, languages and protocols, insuring that no funds would be invested in model development or upgrades unless they meet these protocols, thereby facilitating interoperability.
3. It would assure that model investments would be directed toward extending the capability of extant models and simulations rather than spending significant funds reinventing and re-buying codes which exist or exist in part.

Consortium Benefits?
(Continued)

4. The structure would provide an adequate source of funding to extend *the state of the art* in the M&S base, instead of being at the whim of the Program Manager, typically trying to maximize the short-term return.

5. It would focus national expertise in each technical discipline to assure that decisions on which model investments were indeed needed in each of these disciplines.

6. It would free up the Program Manager's time and attention to other management responsibilities and allow the Consortium to provide the needed M&S support for each respective program.

Defense AT&L
March-April 2006
A PUBLICATION OF THE DEFENSE ACQUISITION UNIVERSITY

DoD's Technical Information Broker

Defense AT&L Interviews
R. Paul Ryan, Administrator
Defense Technical
Information Center

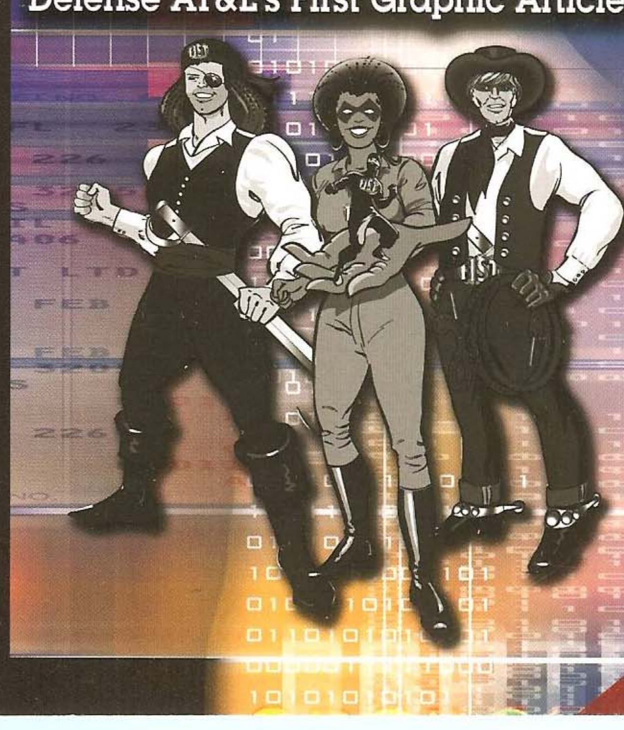
ALSO

America's Imprudent
and Unsustainable
Fiscal Path

David M. Walker,
U.S. Comptroller General

And Introducing

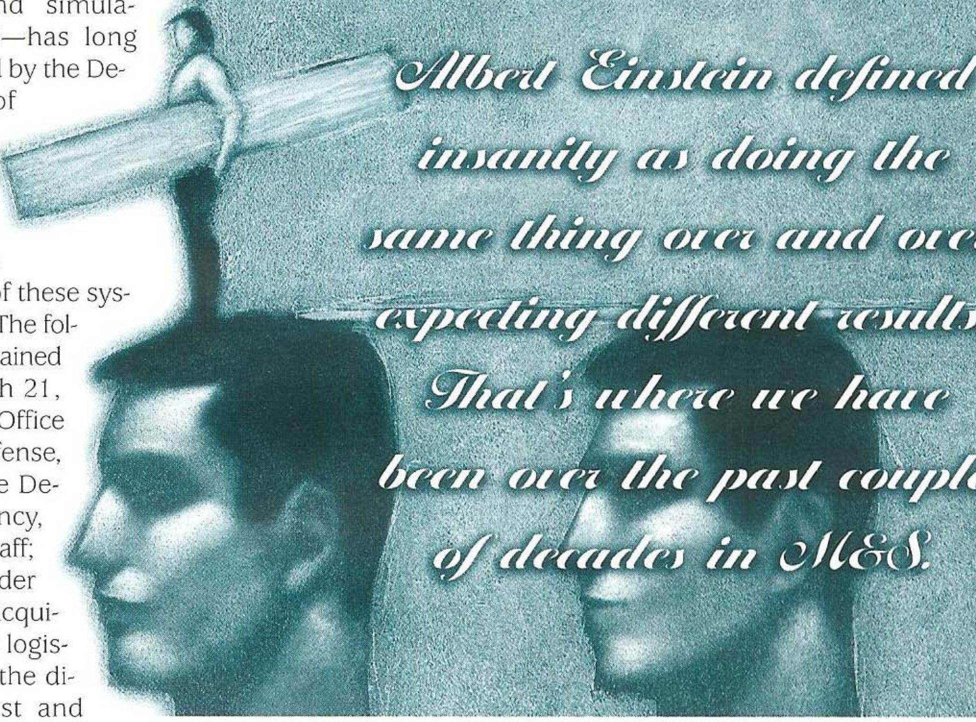
Defense AT&L's First Graphic Article



DoD's Modeling and Simulation Reform in Support of Acquisitior

Stop Kicking the M&S Can Down the Road

James F. O'Bryon



Modeling and simulation—M&S—has long been touted by the Department of Defense as being among its primary methods for reducing time to market for defense systems and reducing the cost of these systems at the same time. The following statement is contained in a letter dated March 21, 2000, addressed to the Office of the Secretary of Defense, Service secretaries, the Defense Intelligence Agency, and the Joint Chiefs of Staff; it is cosigned by the under secretary of defense (acquisition, technology and logistics) (USD(AT&L)) and the director, operational test and evaluation, (DOT&E): "We have stressed that we must make better use of modeling and simulation (M&S) to improve the acquisition process, reduce costs, enhance T&E [test and evaluation], and shorten development times for our new systems. We are convinced that efficient use of M&S throughout the system life cycle will net great dividends in efficiencies."

Few people would argue that M&S is not an important element in the acquisition process. The question is this: Has there been progress within DoD to efficiently organize, fund, develop, promulgate, and maintain configuration control of the DoD's massive and diverse M&S activities to yield the efficiencies so clearly stated in the letter quoted above? Estimates for how much is spent annually on M&S in the DoD range from $5 billion to $30 billion, depending on how one defines M&S. Some of this is spent on M&S in support of training. The majority of the funds, however, are spent in support of the r development, test, and evaluation of new def quisition programs.

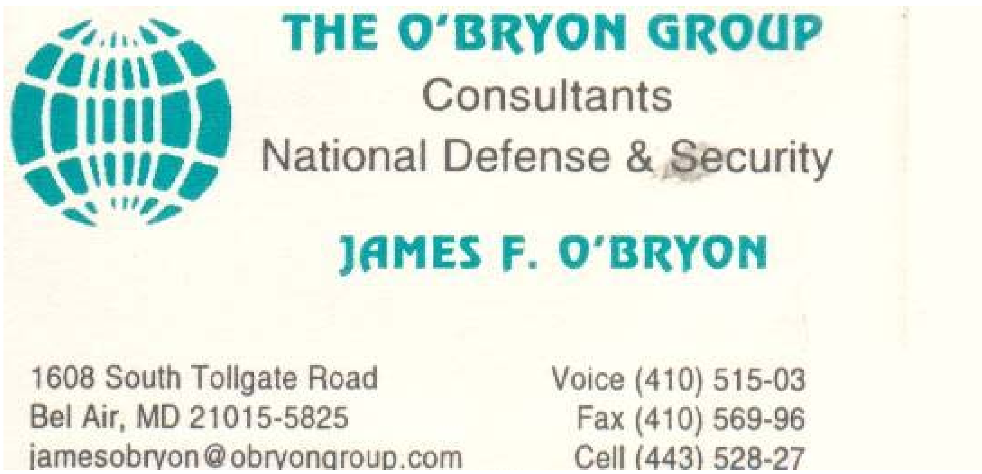
In an article in the July 2005 issue of *National Magazine*, David W. Duma, the Pentagon's acti tor, operational test and evaluation, wrote that fense Department needs to better manage its si programs. I think we've kind of lost our way partment with modeling and simulation. Multip cies are buying duplicate technologies, rather th dinating efforts. We are using more model simulation. But it's not focused, it's scattered. Ev is building their own."

Not a New Problem

I couldn't agree more. So why *does* the DoD co lose its way using more M&S but in a "scattered

O'Bryon *served as deputy director, operational test and evaluation in the Office of the Secretary of Defense until November 2001. He current as a consultant to ORSA Corporation, Aberdeen, Md.*

IF YOU HAVE SOME IDEAS YOU'D LIKE TO SHARE OR WOULD LIKE TO CHALLENGE SOME O THESE IDEAS, I WOULD WELCOME YOUR IDEAS.



Call me at 410-515-0345 or email me at jamesobryon@obryon

Modeling and Simulation of System of Systems The History of the LPD 17 PRA Testbed

M&S Studies in the Context of T&E and Acquisition
LPD 17 PRA Testbed

Vincent M. Ortiz
AVW Technologies

8 March, 2006

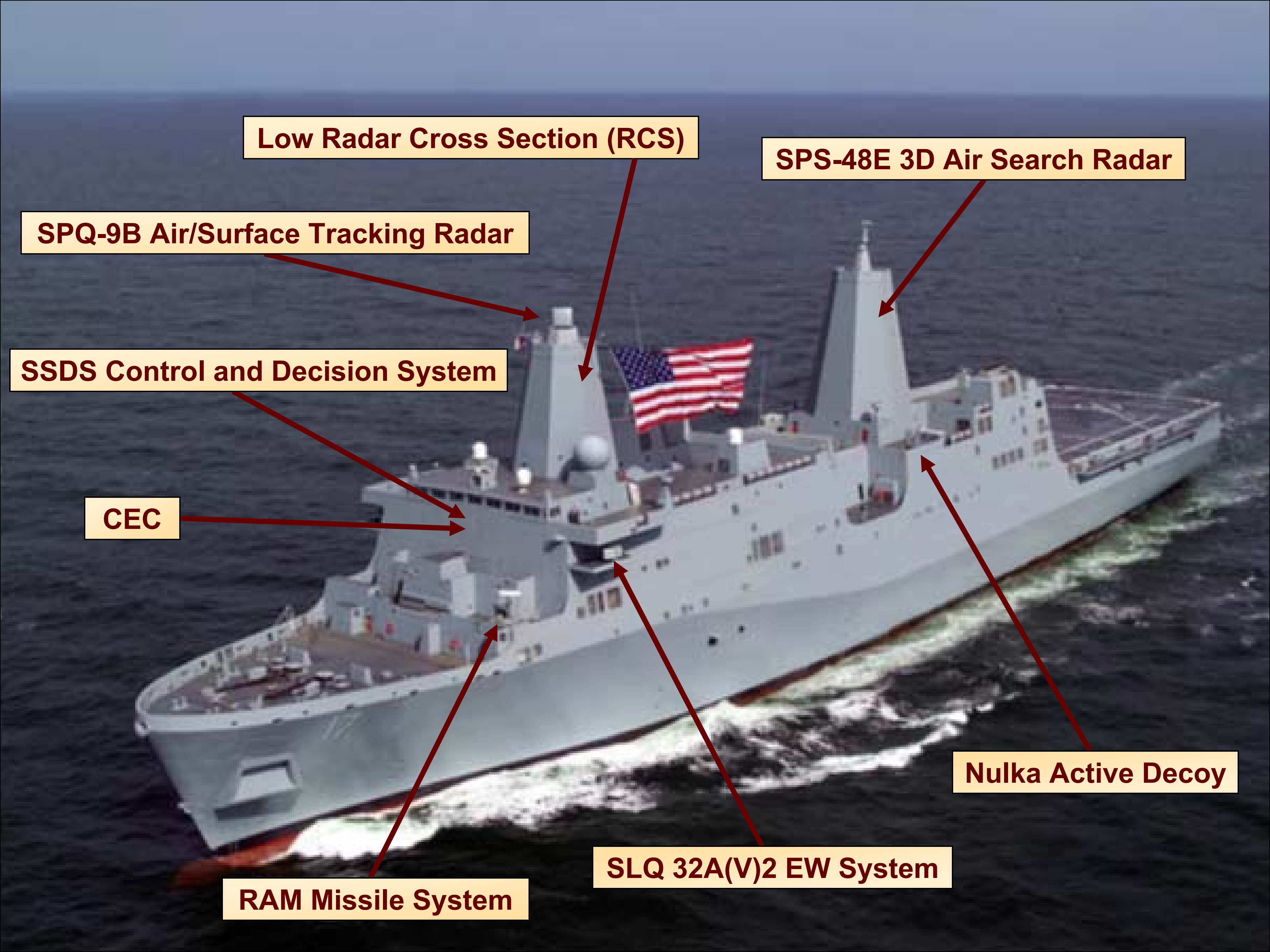
OVERVIEW

- LPD 17 San Antonio Ship Class
- LPD 17 Probability of Raid Annihilation (P_{RA}) Testbed Description and Architecture
- Testbed Development Organization
- Testbed Documents
- Testbed Requirements
- Testbed Development Process
- Testbed Spiral Development and Schedule
- Testbed Analysis and Scenario Development

LPD 17 CAPABILITIES

- **The LPD 17 capabilities include:**
  - State-of-the-art command and control suite
  - Advanced ship survivability features that enhance its ability to operate in the unforgiving littoral environment (low radar cross section)
  - Substantially increased landing force vehicle lift capacity (23,600 square feet of vehicle storage space),
  - Large flight deck (land 2 MV-22 or 4 CH-46) and well deck (holds 2 Landing Craft Air Cushion {LCAC})
- **The LPD 17 is the first amphibious ship designed to accommodate the Marine Corps' "mobility triad"**
  - Expeditionary Fighting Vehicle (EFV)
  - LCAC
  - MV-22 Osprey tilt rotor aircraft.

OUR FOCUS WILL BE ON THE COMBAT SYSTEM



Low Radar Cross Section (RCS)
SPS-48E 3D Air Search Radar
SPQ-9B Air/Surface Tracking Radar
SSDS Control and Decision System
CEC
Nulka Active Decoy
SLQ 32A(V)2 EW System
RAM Missile System

BACKGROUND – P_{RA}

OBJECTIVE: ASSESS LPD 17's P_{RA}
(ABILITY TO DEFEND ITSELF AGAINST INCOMING MISSILES)

- **CNO's Anti-Air Warfare Capstone Requirements Document mandated the ship self defense capability for specific ship classes and established the Probability of Raid Annihilation (P_{RA}) as the primary Measure of Effectiveness (MOE) to assess ship combat system suites.**

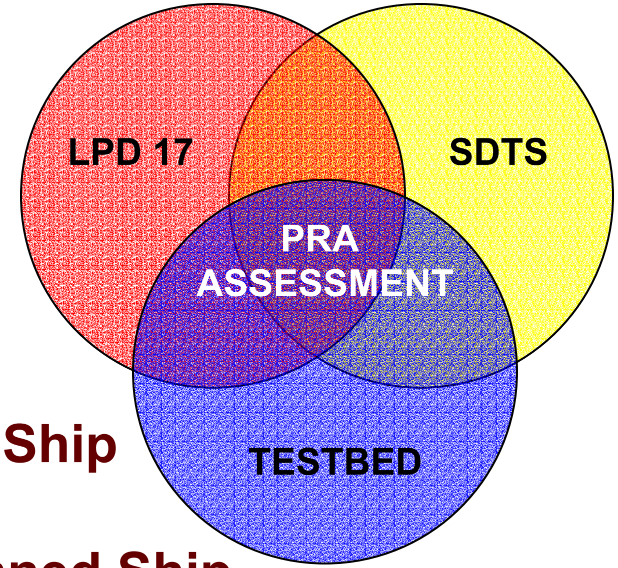
- **P_{RA} is defined as the ability of a particular stand-alone ship, as an integrated system, to detect, control, engage, and defeat a specified raid of anti-ship cruise missile (ASCM) threats with a specified level of probability in the operational environment.**

- **The P_{RA} MOE is a system-of-systems measure which is levied on the ship defense suite as a whole to properly detect, control, and engage (annihilate) a raid of incoming threat ASCMs. Thus, it doesn't measure the performance of any particular ship defense element; rather it measures the system performance of all the ship defense elements across the complete battle timeline.**

- **The LPD 17 class is the first U.S. Naval ship class required to demonstrate its ability to defeat specific anti-ship cruise missile threats to achieve a statistical P_{RA}.**

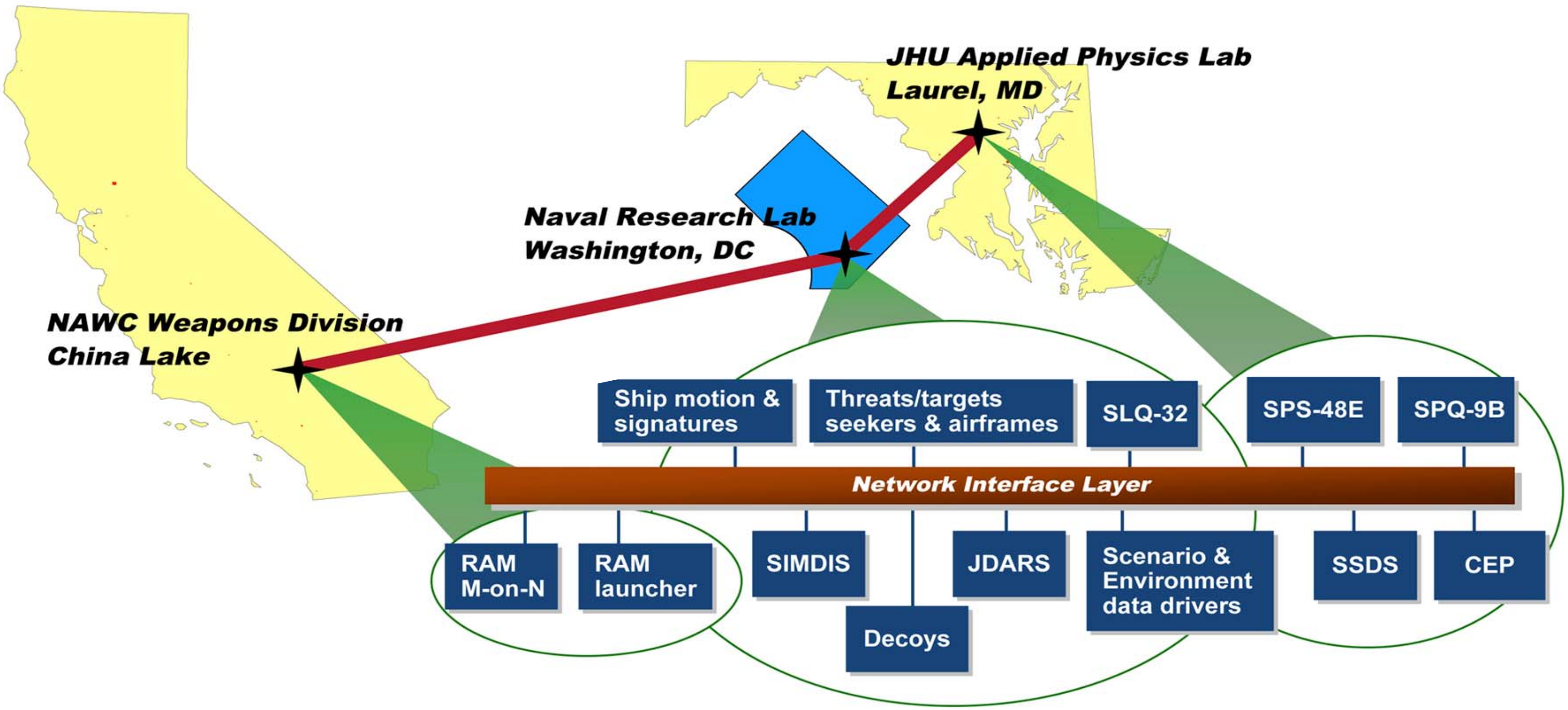
AVW TECHNOLOGIES

NAVY'S SOLUTION TO PRA



- PRA Assessment is a Three Pronged Approach
  - Test against actual ship (LPD 17)
    - Pro – Test Drones Against the Actual Ship
    - Con – Limited Firing Events, Cannot Fire ASCM Against Manned Ship
  - Test against Self Defense Test Ship (SDTS)
    - Pro – Can Fire ASCM Against SDTS
    - Con – Limited Representation of the Actual Ship, Limited Firing Events
  - Test using M&S (LPD 17 Testbed)
    - Pro – Can Runs Numerous Different Scenarios, Events
    - Con – Developmental Cost, Limiting Assumptions

LPD 17 PRA TESTBED



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Geographically Distributed Federation of Tactical HWIL, Tactical SWIL and Digital Physics Based Models

OVERVIEW

- LPD 17 San Antonio Ship Class
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LPD 17 PRA TESTBED OVERVIEW

MANAGEMENT APPROACH:

Organization
Meetings
Documents
Schedule

TECHNICAL APPROACH:

Physics - Based
Non – Real Time
Distributed, RTI Solution
HLA Compliant
Spiral Development

SYSTEM OF SYSTEMS SOLUTION

BOUND THE PROBLEM:

Testbed Requirements
Fidelity
Ship Configuration
Environment
Threat Types

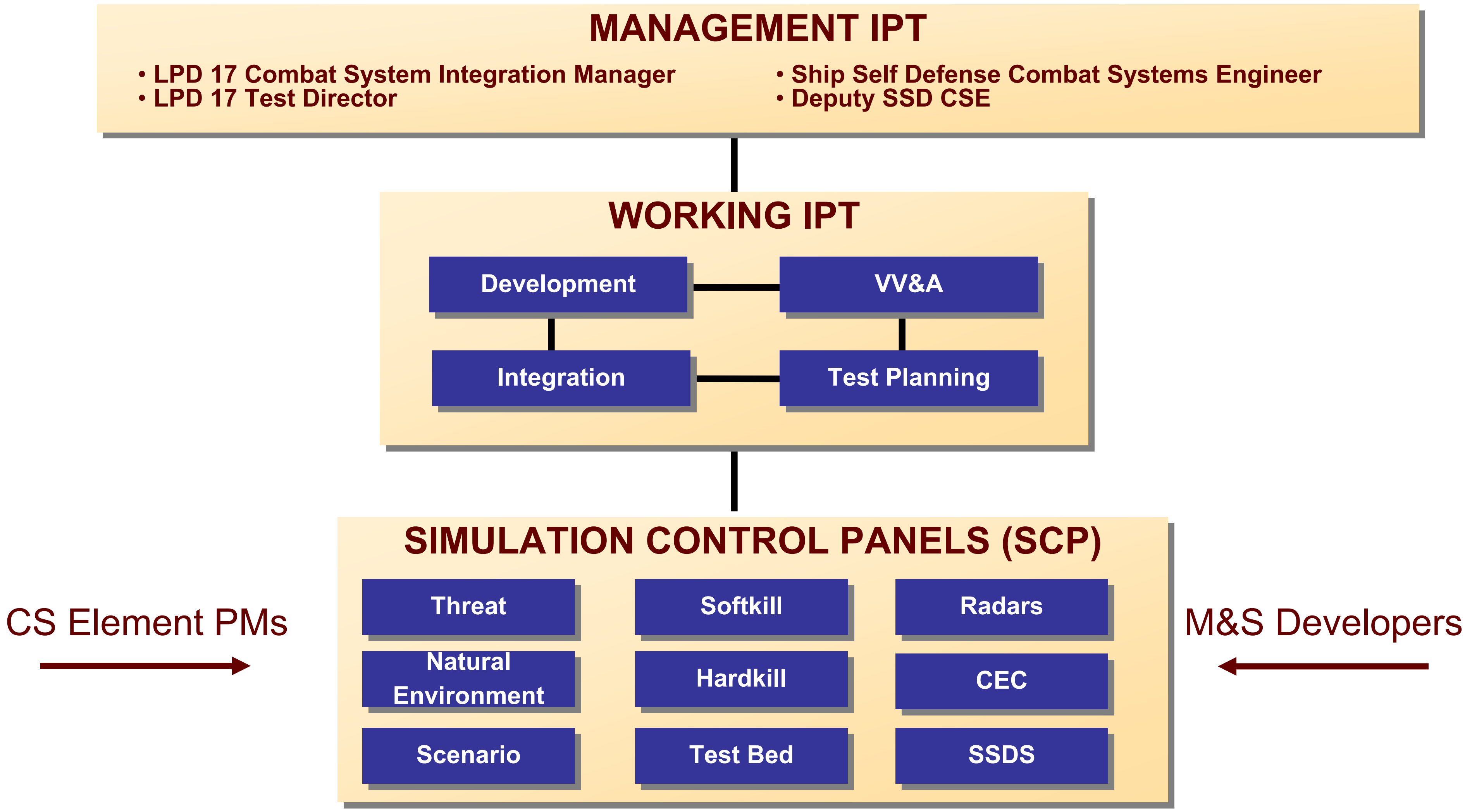
BOUND THE ANALYSIS:

Finite Number of Runs
(Geographic Location
Ship Configuration
Season, Time of Day
Threat Types)

ROLES & RESPONSIBILITIES

- PMS 317
  - Manages Funding
  - Drives Schedule
  - V&V Manager
  - DT Accrediting Authority
- PEO IWS CSE
  - Manages Testbed Design and Development
- NRL
  - Testbed Integrator
- NSWC Corona
  - Test Resource, Planning and Data Collection Agent
- Element PMs
  - Co-Chair SCP.
  - Review & Approve SOWs associated with M&S Development.
  - Manage/ Participate in Model Development.
  - Responsible for the Credibility of their Respective Models
- Model Developers
  - Develops/ Integrates Models
- COMOPTEVFOR
  - Participates as the OT Accrediting Authority

LPD 17 P_{RA} ORGANIZATION



TESTBED MEETINGS

SCP MEMBERS, DEVELOPERS, EXPERTS

WORKING IPT MEMBERS

MANAGEMENT IPT MEMBERS

Semi-Annual Reviews

Testbed Demonstrations

Monthly Testbed Meetings

Periodic Meetings – Specific Issues

Federation Object Model Meetings

Phenomena Meetings

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AVW TECHNOLOGIES

TESTBED DOCUMENTS

REQUIREMENTS DOCUMENT

Testbed and Model Requirements

Defined at the Beginning

TESTBED AND MODEL BUILD PLAN & REPORT

Technical Approach
Functionality Per Build
Configuration Management
Integration Plan and Report

SECM

System Engineering Conceptual Model

Illustrates Model Relationships (Links to Supporting Documents)

VERIFICATION & VALIDATION PLAN AND REPORT

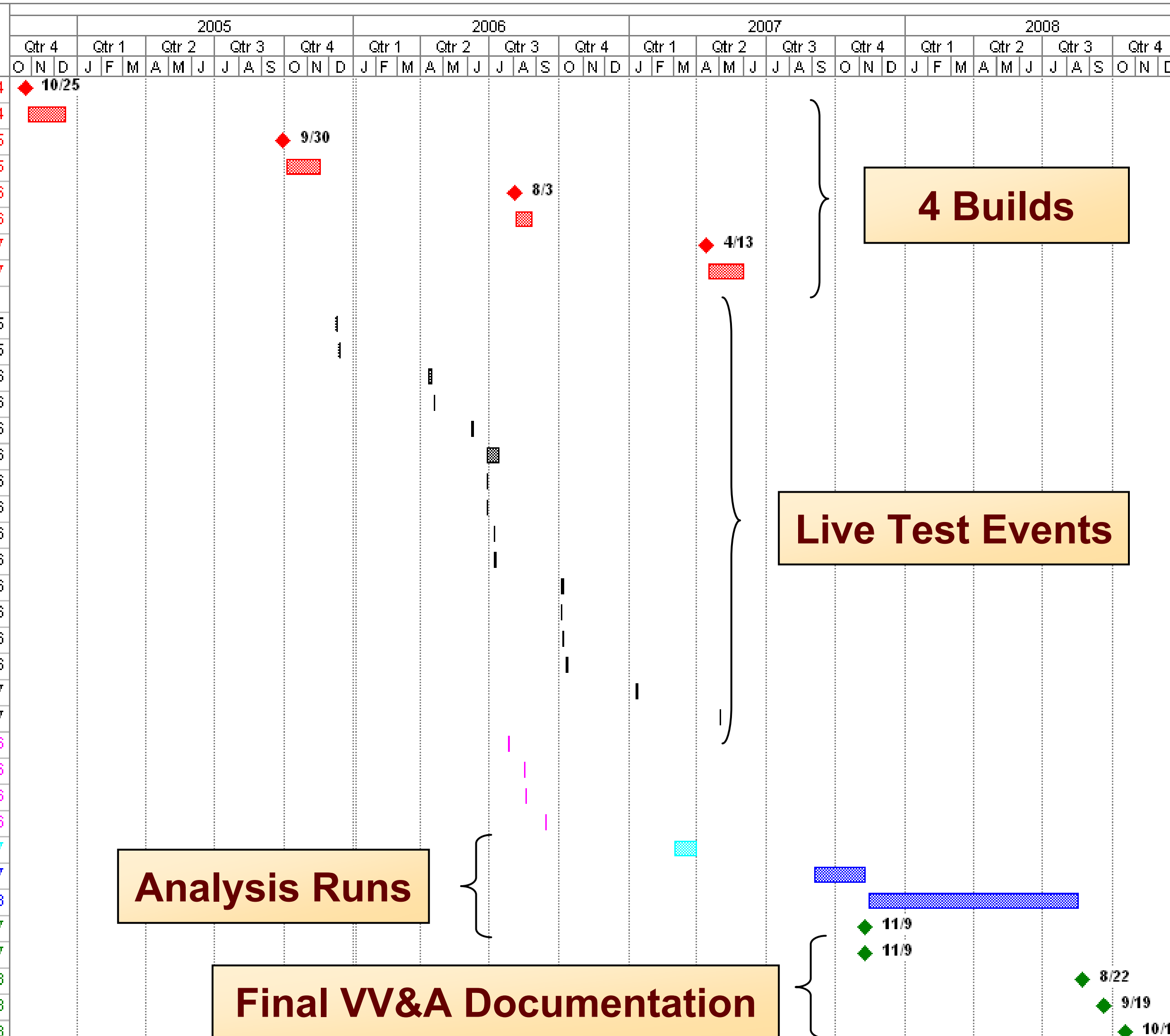
Derived from the Requirements
Generated from Relational Database

AVW Process developed the Approach, Requirements and Build Plan
AVW Database Produced the Requirements and VV&A Documents

AVW TECHNOLOGIES

TESTBED SCHEDULE

ID	Task Name	Start	Finish
1	Model Build 1	Mon 10/25/04	Mon 10/25/04
2	Testbed Build 1	Tue 10/26/04	Wed 12/15/04
3	Model Build 2	Fri 9/30/05	Fri 9/30/05
4	Testbed Build 2	Mon 10/3/05	Wed 11/16/05
5	Model Build 3	Thu 8/3/06	Thu 8/3/06
6	Testbed Build 3	Fri 8/4/06	Thu 8/24/06
7	Model Build 4	Fri 4/13/07	Fri 4/13/07
8	Testbed Build 4/Final	Mon 4/16/07	Thu 5/31/07
9			
10	SSDS TE #1	Thu 12/8/05	Sat 12/10/05
11	SPS-48E Characterization Testing	Mon 12/12/05	Tue 12/13/05
12	SSDS TE #2	Mon 4/10/06	Fri 4/14/06
13	SESEF/SEMCIP	Mon 4/17/06	Wed 4/19/06
14	SSDS DTE TE #3	Mon 6/5/06	Thu 6/8/06
15	CSSQT U/W	Tue 6/27/06	Wed 7/12/06
16	A/C Trackex	Mon 6/26/06	Mon 6/26/06
17	DT/DTE	Tue 6/27/06	Tue 6/27/06
18	MSLEX (BQM 34)	Wed 7/5/06	Thu 7/6/06
19	RCSR Measurement	Thu 7/6/06	Sat 7/8/06
20	SSDS TE #4	Mon 10/2/06	Thu 10/5/06
21	A/C Trackex	Mon 10/2/06	Tue 10/3/06
22	DTE	Wed 10/4/06	Thu 10/5/06
23	DT/OT Firings	Mon 10/9/06	Thu 10/12/06
24	SSDS DTE TE #5	Mon 1/8/07	Thu 1/11/07
25	RCSR Validation	Mon 4/30/07	Tue 5/1/07
26	SDTS OP 1	Tue 7/25/06	Tue 7/25/06
27	SDTS OP 2	Tue 8/15/06	Tue 8/15/06
28	SDTS OP 3	Thu 8/17/06	Thu 8/17/06
29	SDTS OP 4	Tue 9/12/06	Tue 9/12/06
30	LPD 18 Nulka	Thu 3/1/07	Sat 3/31/07
31	Dry Runs	Mon 9/3/07	Fri 11/9/07
32	Analysis Runs	Mon 11/12/07	Fri 8/15/08
33	Draft V&V Report	Fri 11/9/07	Fri 11/9/07
34	Preliminary DT Accreditation	Fri 11/9/07	Fri 11/9/07
35	Final V&V Report	Fri 8/22/08	Fri 8/22/08
36	Final DT Accreditation	Fri 9/19/08	Fri 9/19/08
37	OT Recommendation to COTF	Fri 10/17/08	Fri 10/17/08



OVERVIEW

- **LPD 17 San Antonio Ship Class**
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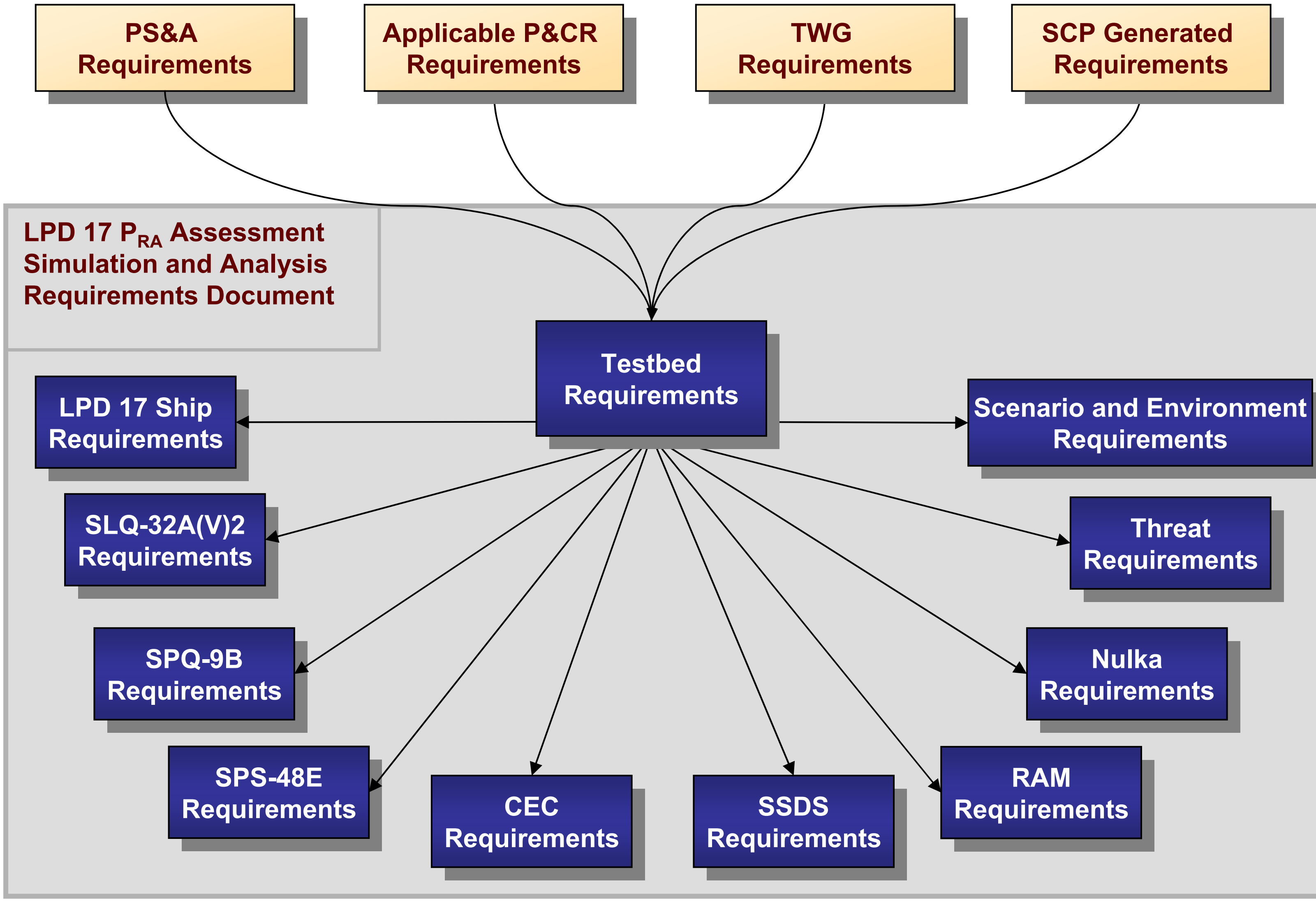
- **Testbed Spiral Development and Schedule**
- **Testbed Analysis and Scenario Development**

TESTBED REQUIREMENTS FLOW



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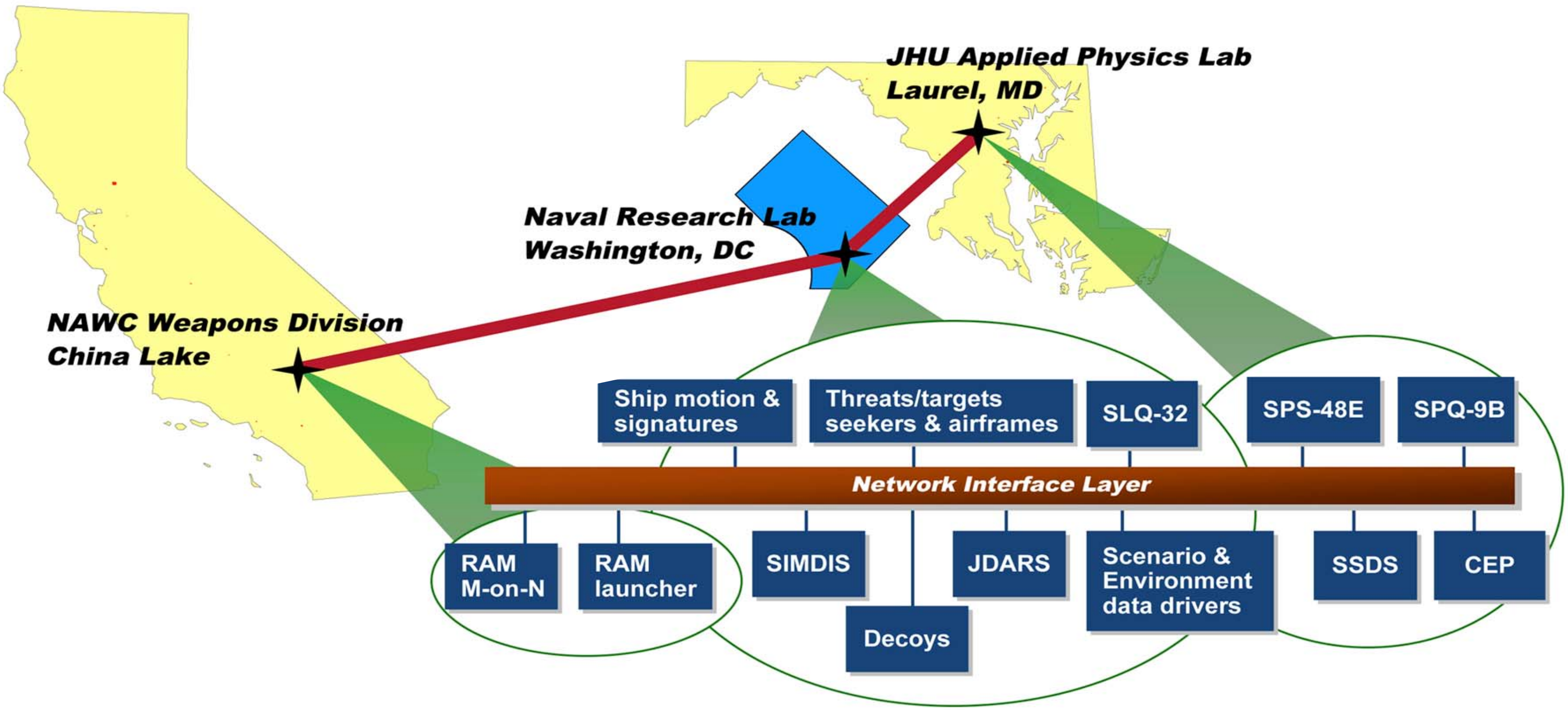
LPD 17 PRA TESTBED



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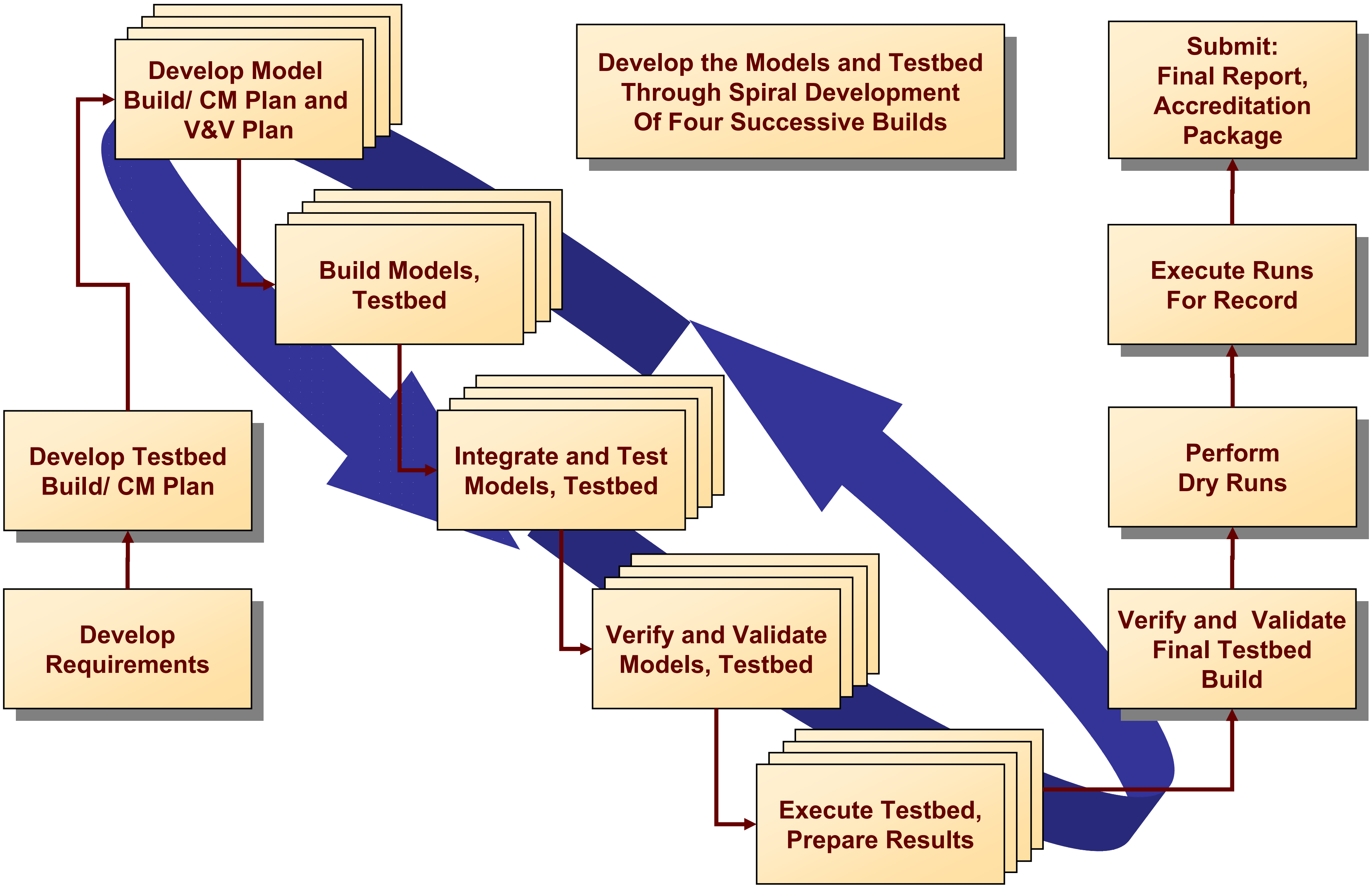
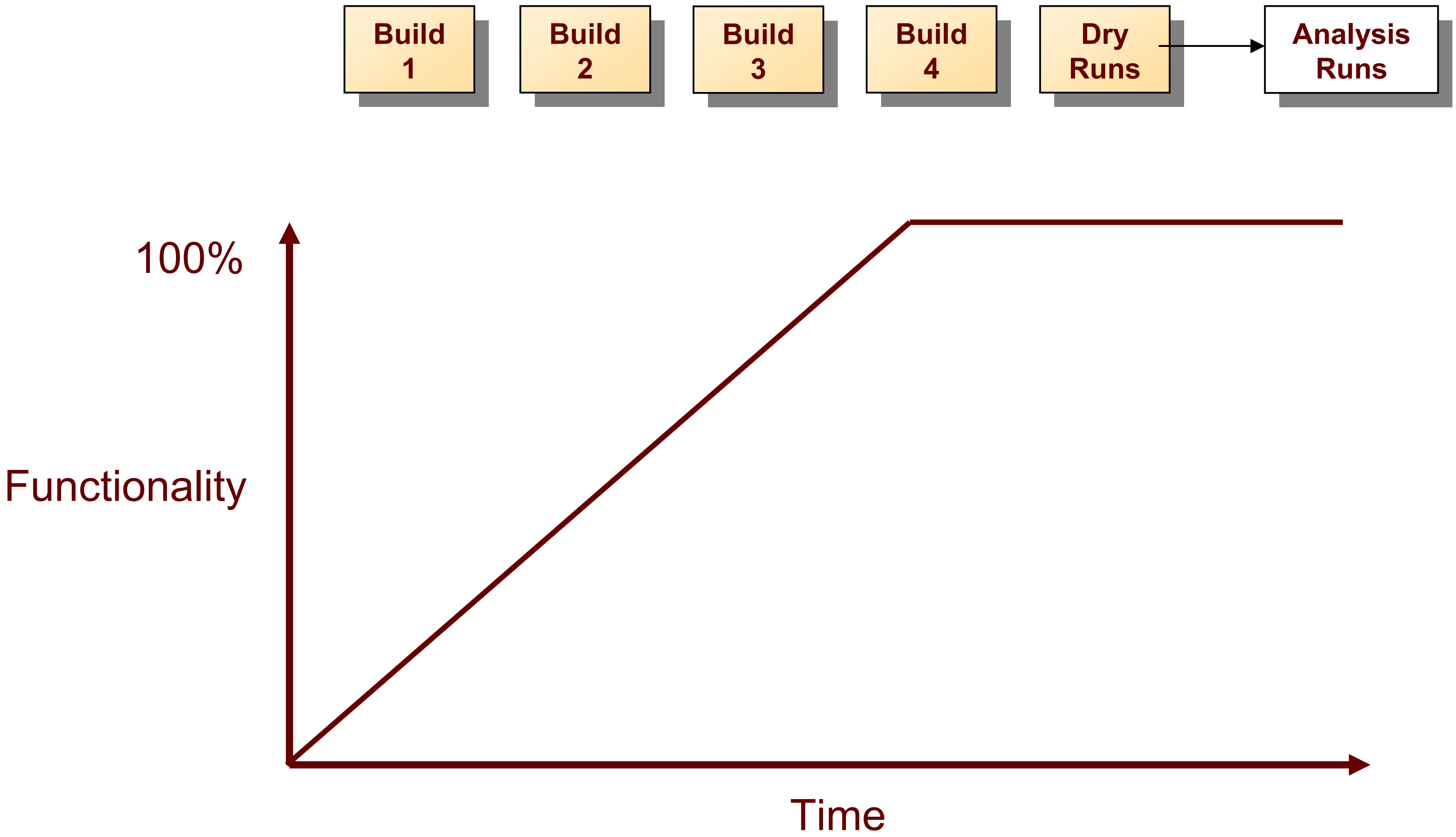
Geographically Distributed Federation of Tactical HWIL, Tactical SWIL and Digital Physics Based Models

TESTBED SPIRAL DEVELOPMENT



DEVELOPMENT TIMELINE



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ANALYSIS OVERVIEW

- Objective – to bound a problem having infinite possibilities.
- Number of variables limited by time to perform analysis runs
- Make analysis space finite and within a reasonable operational context.
- Not skewed in any one point of view.
- Scientifically supported; no need spending money on physics excursions.
- Approach should be consistent across ship classes.
- The scenarios are scripted to prevent other ships, LCACs, and aircraft from interfering with the engagement sequence.
- The threat should not be distracted from its target by these other units in the scenario.

AVW TECHNOLOGIES

SCENARIO OVERVIEW

- **Background**
  - **LPD 17 is part of an Expeditionary Strike Group (ESG).**
  - **Early detection and engagement of the launching platform is not in the context of the PRA Assessment since its focus is ASCM self defense.**
  - **Battle force networking, force link tracking and force cooperative engagements standpoint are not supported by the LPD 17 PRA self defense context; therefore, the ship will be in a worst case situation with no data links active, requiring it to perform the entire detect-to-engage sequence on its own.**

- **Initial Conditions**
  - **Detailed geometries, tactics, and operational situations will be developed to provide boundary/initial conditions for each run as well as to drive the variables during the run to ensure operationally realistic and consistent runs for analysis.**

SCENARIO - THREATS

- Combat System Setup
  - Conducting wartime transit steaming and mission operations with the ship's defensive systems set up to counter ASCM threats automatically.
  - No operator actions required except for NULKA launches, which will be treated as a time delay in the automatic engagement sequence based on nominal operator reaction times.
  - Surface Warfare Development Group (SWDG) Tactical Memorandums (TACMEMOs) and other tactics and doctrine publications will be used to configure the LPD 17 Combat System representation in the Testbed for execution of each simulated engagement run.

- Threats
  - Threats will be fired in stream raids of x sec spacing, from eight true bearings (±8º) about the compass rose.
  - Intelligence on threats and threat tactics will be used to develop detailed threat engagement scenarios for each run.
  - A set of 5 representative threats were selected.

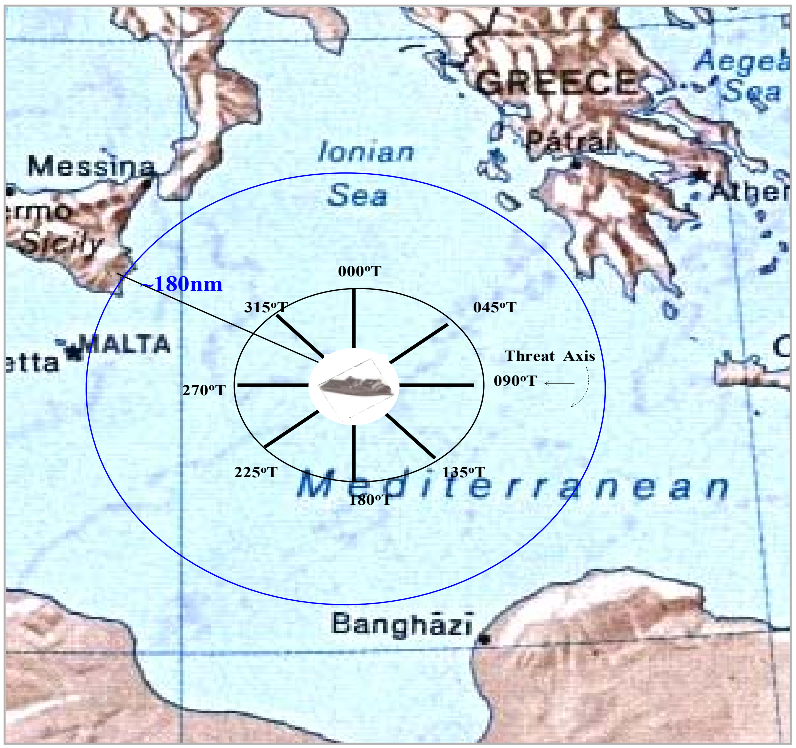
SCENARIO – SHIP CONFIG

- Case 1 – “Clean” RCS
  - The lowest possible realistic RCS and IR values representative of the ship in transit condition in wartime.
  - The flight deck will be as free of aircraft and yellow gear as possible.
  - The stern gate will be closed.
- Case 2 – “Dirty” RCS
  - Near worst possible realistic RCS and IR values representative of the ship in an operational environment conducting well deck and aviation operations.
  - SH-60s or MV-22s (whichever has higher RCS value) will be chained on the deck.
  - Stern gate will also be open with the well deck empty of LCACs and water.

SCENARIO - ENVIRONMENT

- Approach
  - Provide representative sample space of environmental and other variables such as water vapor, specific humidity, particulates, temperature, air pressure, ducting, sea state 3 and associated wind direction, wind speed, wave height and wave direction, as well as sun angle.
- Season
  - Summer Scenario
  - Winter Scenario
- Time of Day
  - Shortly after Sunrise
  - Noon
  - Afternoon
  - Shortly before Sunset
  - Midnight
- Sea State
  - Established as Sea State 3 for All Scenarios

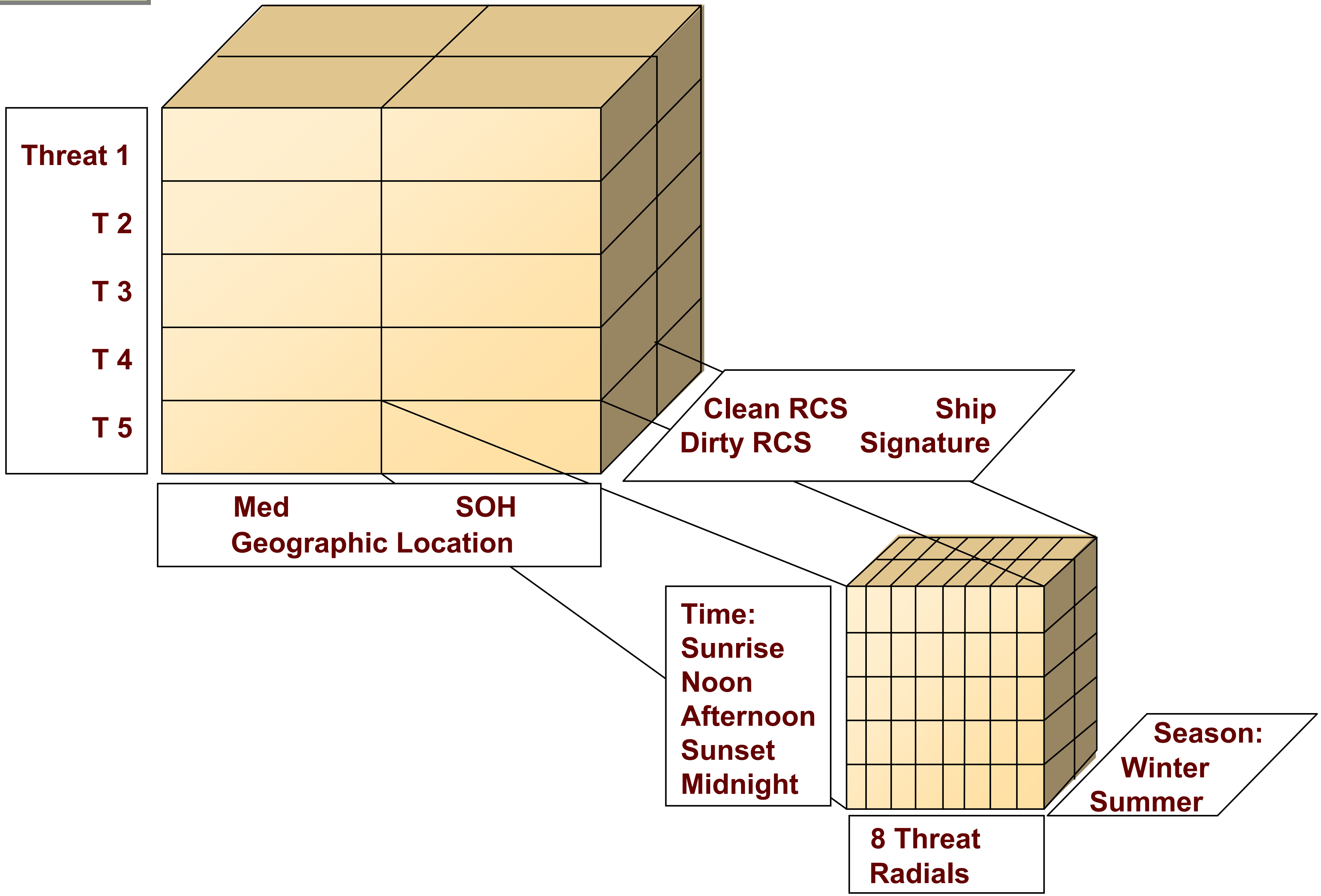
SCENARIO - GEOGRAPHIES



Geography 1
Open Ocean - Mid-Med

Geography 2
Straits of Hormuz

SCENARIO VARIABLES



ANALYSIS APPROACH

- 2 Geographies
  - Med Open Ocean
  - Straits of Hormuz
  - Provides Stressing and Non-Stressing Locations
- 2 Environments
  - 2 Times of Year
  - 5 Times of Day
  - No Rain
  - Provides Nominal Changes in Environment
- 2 Radar Cross Sections
  - Clean, Minimized RCS
  - Dirty, Open Well, Helo on Deck
  - Provides Large and Small Signatures
- 5 Threats
  - T1R1, T2, T3, T5, T7
  - 8 Threat Bearings
  - 45 Deg Intervals
  - Provides Combat System Performance from all Directions

PERFORM ONE RUN FOR EACH COMBINATION OF 6 VARIABLES
STATISTICALLY A REPRENTATIVE SAMPLING THROUGH THE SPACE

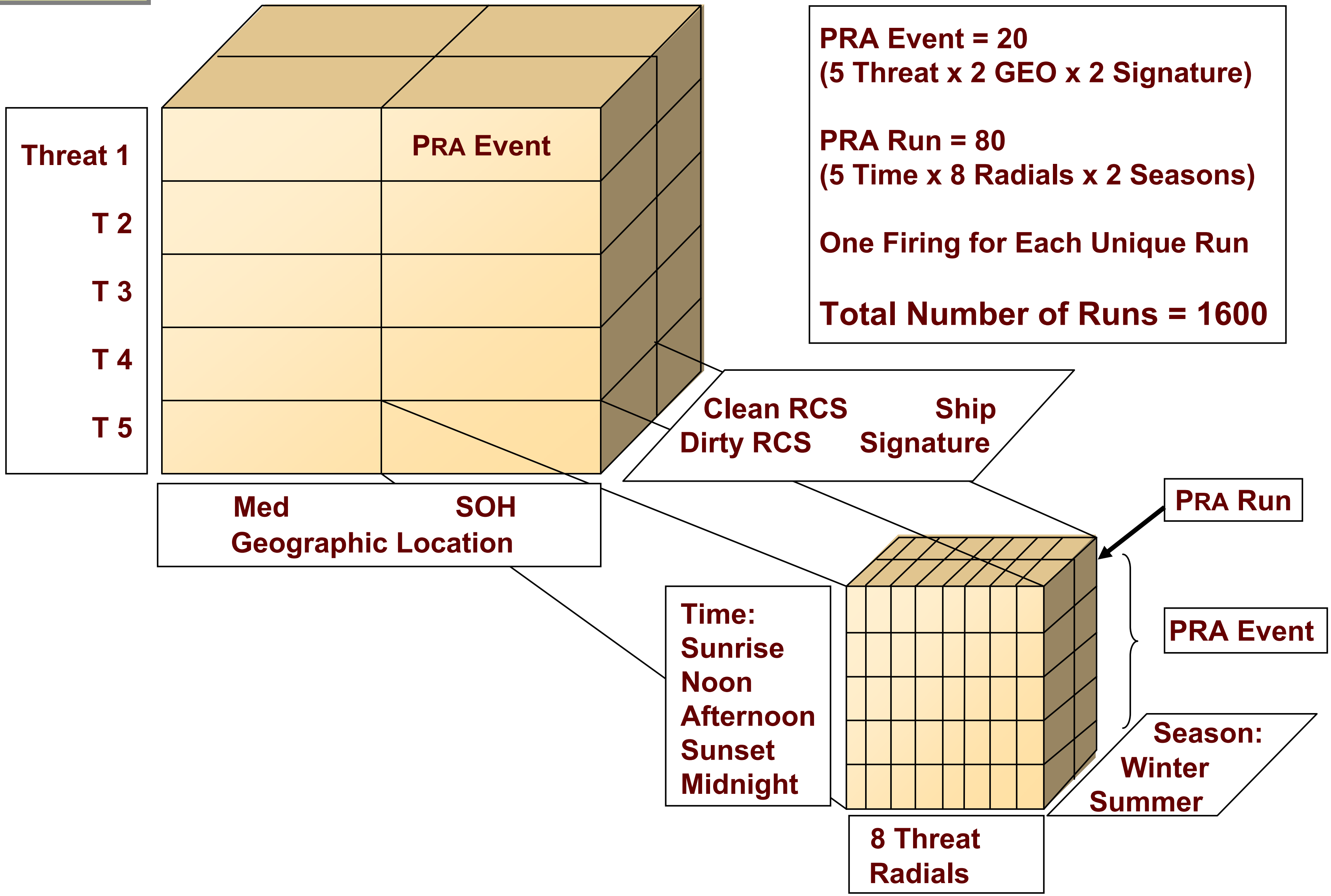
TESTBED SAMPLE SPACE

PRA Event = 20
(5 Threat x 2 GEO x 2 Signature)

PRA Run = 80
(5 Time x 8 Radials x 2 Seasons)

One Firing for Each Unique Run

Total Number of Runs = 1600



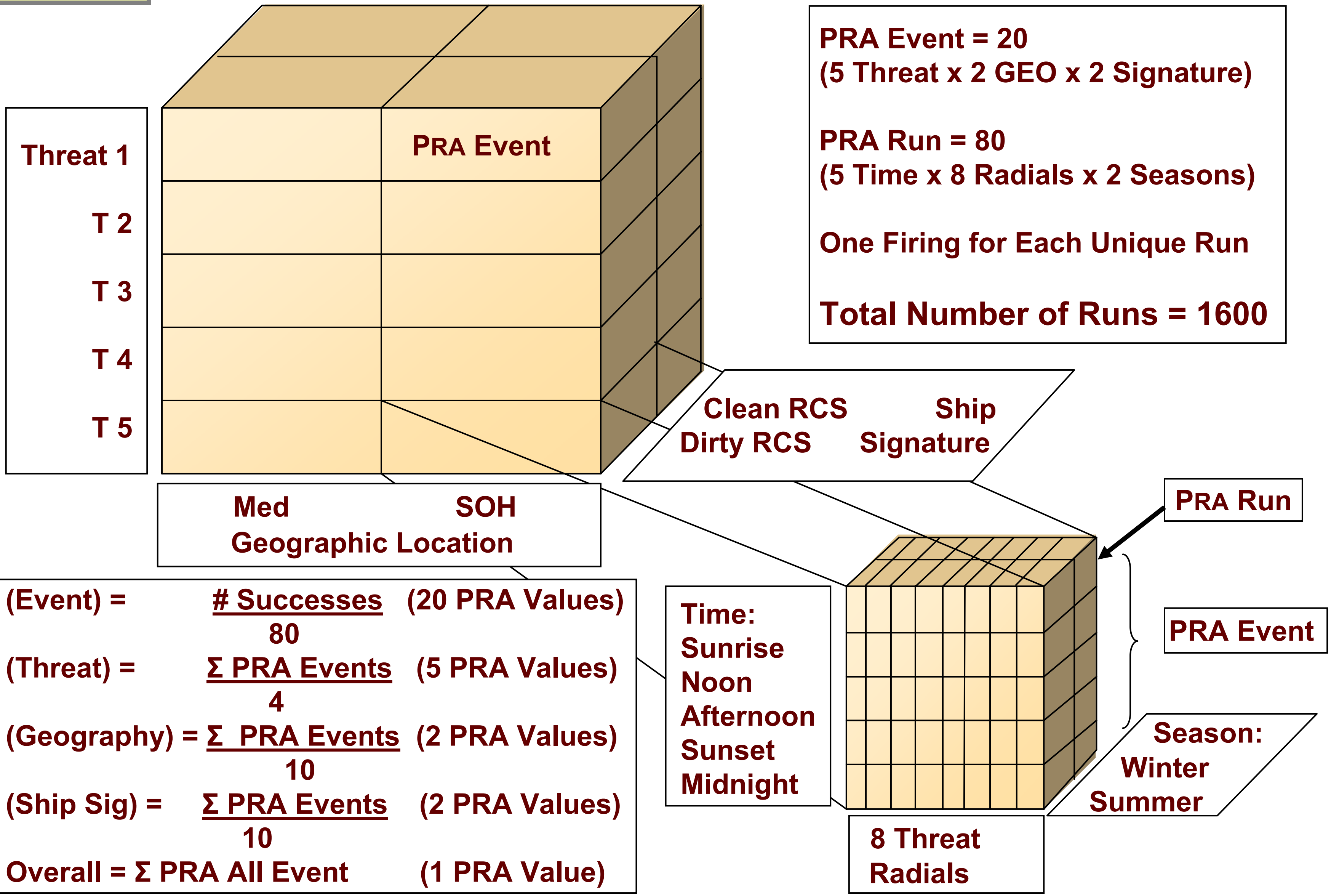
TESTBED PRA CALCULATIONS

PRA Event = 20
(5 Threat x 2 GEO x 2 Signature)

PRA Run = 80
(5 Time x 8 Radials x 2 Seasons)

One Firing for Each Unique Run

Total Number of Runs = 1600



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AVW TECHNOLOGIES

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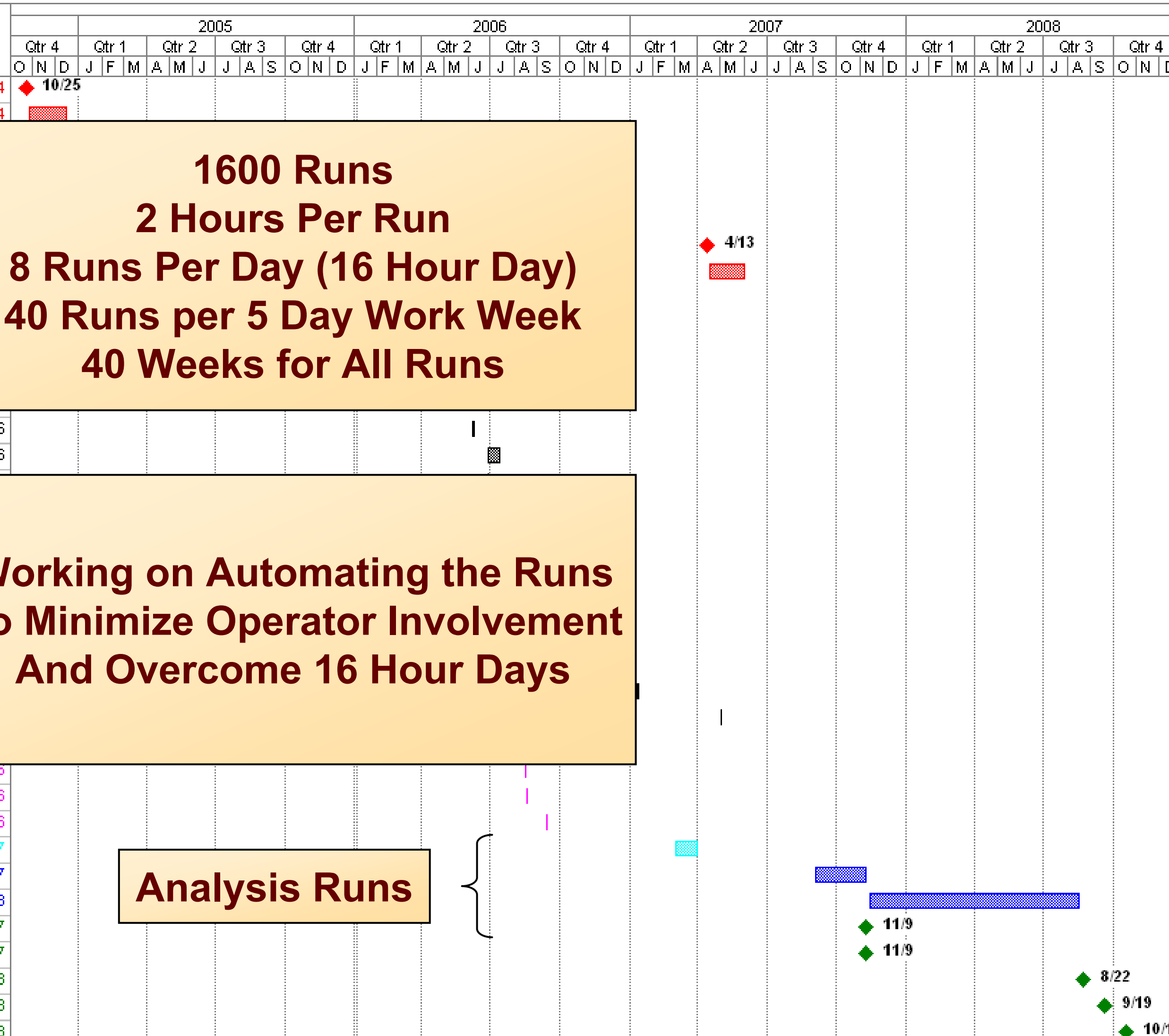

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2 Hours Per Run
8 Runs Per Day (16 Hour Day)
40 Runs per 5 Day Work Week
40 Weeks for All Runs

Working on Automating the Runs
To Minimize Operator Involvement
And Overcome 16 Hour Days

Analysis Runs

ANALYSIS – KEY EVENTS

- Identify Key Events During Engagement
  - Sensor Performance, Sensor Messages, Weapons Orders, Weapons Performance, Engagement Outcome
- Data Collected and Displayed Live During Runs
- Used to Verify, Troubleshoot Testbed Performance
- Used to Calculate Various PRA Values

SUMMARY

Success for Testbed Development Based On:

- Clearly Defined Requirements
- Testbed Organization and Roles Well Understood
- Documents Contain Necessary Information
- Spiral Development and Schedule
- Execute Phases of Simulation Development
- Pragmatic Scenario Development
- Systematic Analysis Approach
- Collection, Manipulation and Presention of PRA Values

BACKUP SLIDES

A Case Study of T&E Data Supporting A Simulation

LPD 17 PRA Testbed

Vincent M. Ortiz

AVW Technologies

9 March, 2006

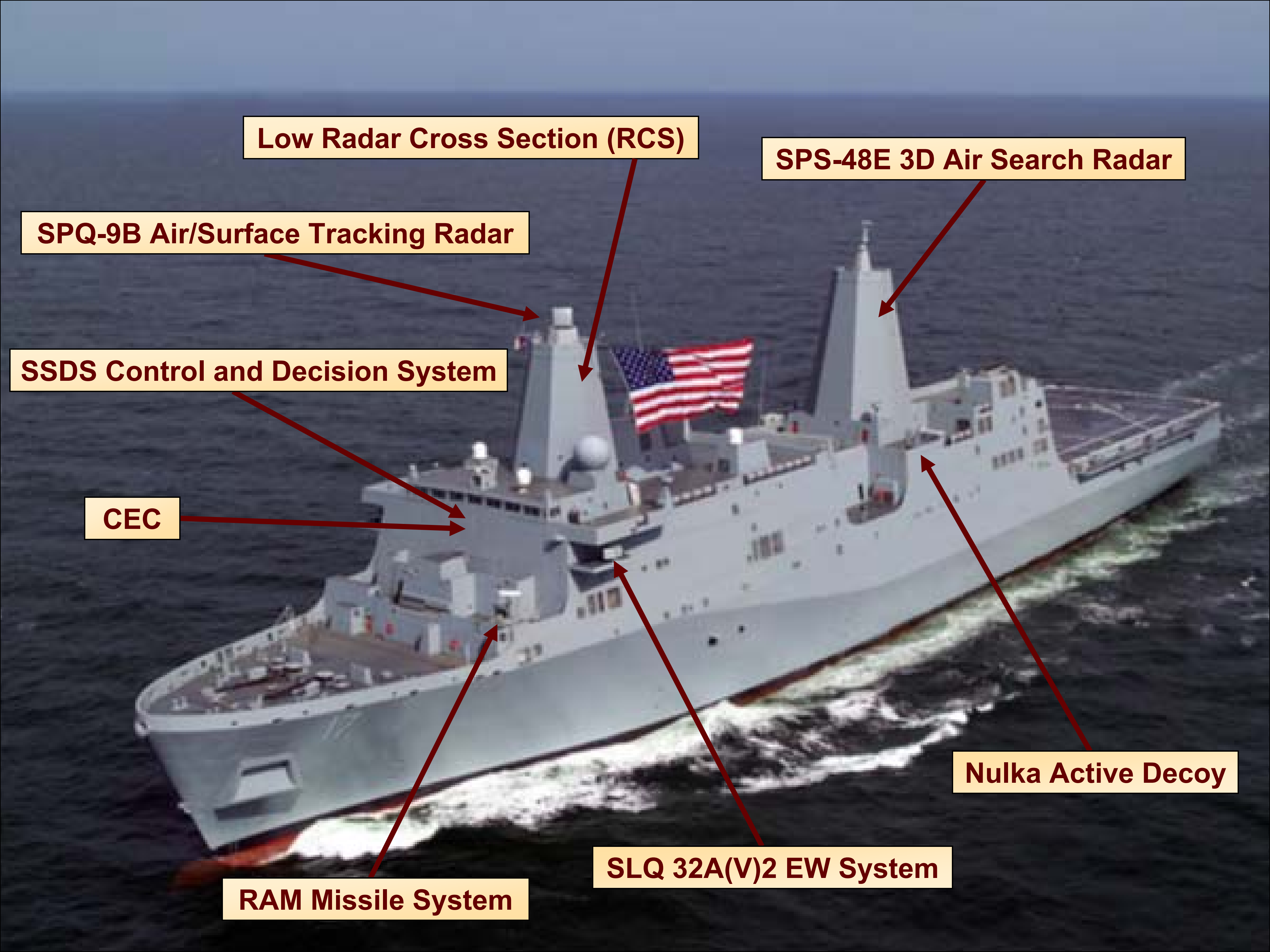
OVERVIEW

- LPD 17 San Antonio Ship Class
- LPD 17 Probability of Raid Annihilation (P_{RA}) Testbed Description and Architecture
- Historical vs Integrated Approach to Testing
- PRA Analysis
- Validating the LPD 17 Testbed
- Organizational Approach to Have T&E Data Support the LPD 17 PRA Testbed

LPD 17 CAPABILITIES

- **The LPD 17 capabilities include:**
  - **State-of-the-art command and control suite**
  - **Advanced ship survivability features that enhance its ability to operate in the unforgiving littoral environment (e.g., low radar cross section)**
  - **Substantially increased landing force vehicle lift capacity (23,600 square feet of vehicle storage space)**
  - **Large flight deck (land 2 MV-22 or 4 CH-46) and well deck (holds 2 Landing Craft Air Cushion {LCAC})**
- **The LPD 17 is the first amphibious ship designed to accommodate the Marine Corps' "mobility triad"**
  - **Expeditionary Fighting Vehicle (EFV)**
  - **LCAC**
  - **MV-22 Osprey tilt rotor aircraft.**

OUR FOCUS WILL BE ON THE COMBAT SYSTEM


Low Radar Cross Section (RCS)
SPS-48E 3D Air Search Radar
SPQ-9B Air/Surface Tracking Radar
SSDS Control and Decision System
CEC
Nulka Active Decoy
SLQ 32A(V)2 EW System
RAM Missile System

BACKGROUND – P_{RA}

OBJECTIVE: ASSESS LPD 17's P_{RA}
(ABILITY TO DEFEND ITSELF AGAINST INCOMING MISSILES)

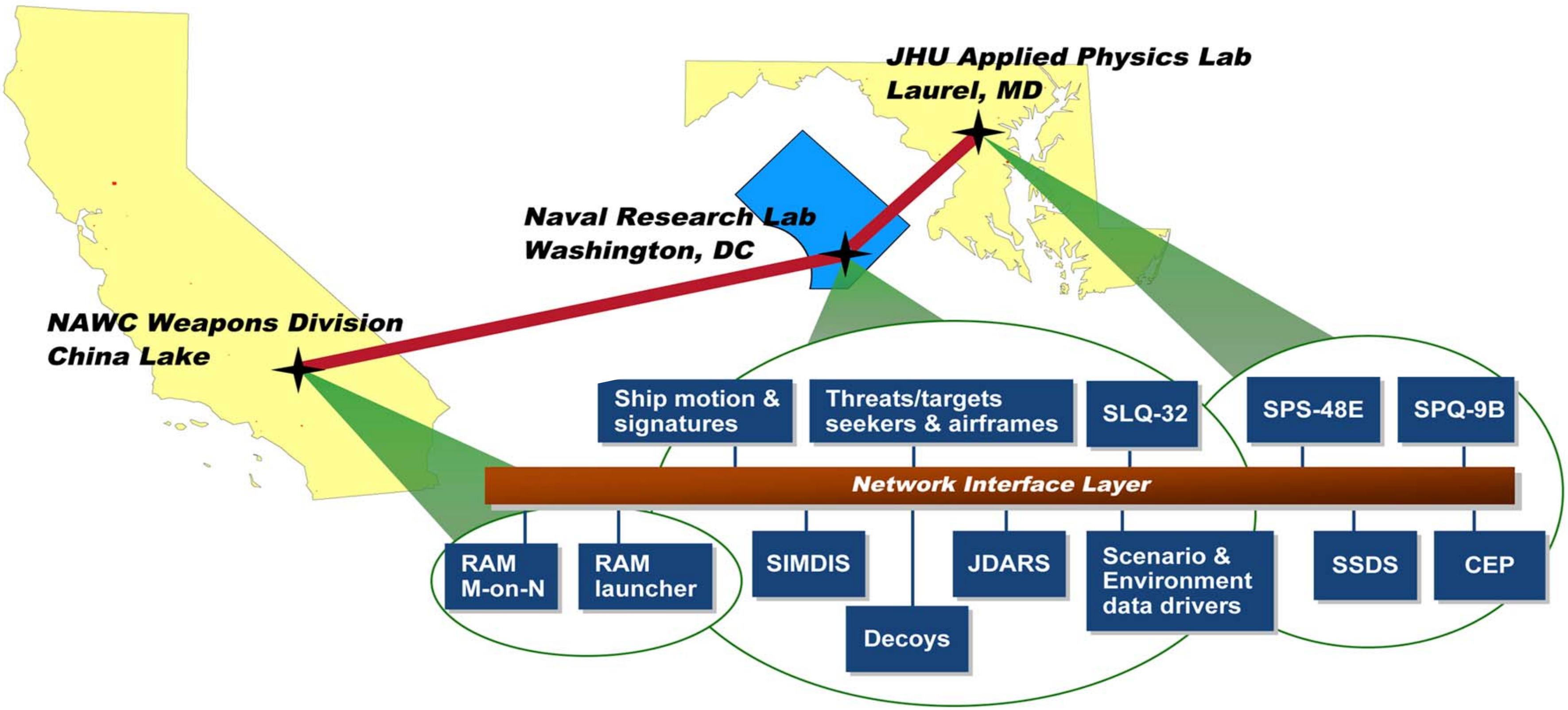
- **CNO's Anti-Air Warfare Capstone Requirements Document mandated the ship self defense capability for specific ship classes and established the P_{RA} as the primary Measure of Effectiveness (MOE) to assess ship combat system suites.**

- **P_{RA} is defined as the ability of a particular stand-alone ship, as an integrated system, to detect, control, engage, and defeat a specified raid of anti-ship cruise missile (ASCM) threats with a specified level of probability in the operational environment.**

- **The P_{RA} MOE is a system-of-systems measure which is levied on the ship defense suite as a whole to properly detect, control, and engage (annihilate) a raid of incoming threat ASCMs. Thus, it doesn't measure the performance of any particular ship defense element; rather it measures the system performance of all the ship defense elements across the complete battle timeline.**

- **The LPD 17 class is the first U.S. naval ship class required to demonstrate its ability to defeat specific anti-ship cruise missile threats to achieve a statistical P_{RA}.**

LPD 17 PRA TESTBED



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Geographically Distributed Federation of Tactical HWIL, Tactical SWIL and Digital Physics Based Models

NAVY CATEGORIES OF TESTING

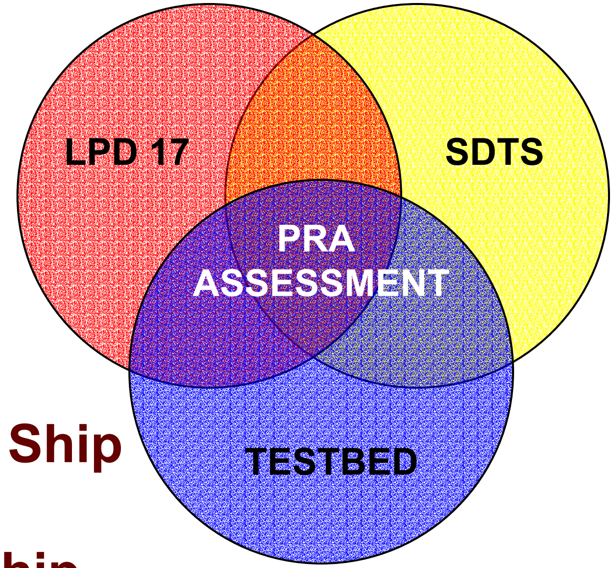
- Land Based Test Site (LBTS) Testing
- Lead Ship Testing/
  Operational Testing (OT)
  - Each New Ship Class
  - Each New Combat System Element
- Self Defense Test Ship (SDTS) and Test Events
- PRA Modeling and Simulation

Navy Initiative Underway to Combine and Optimize Testing of New Systems
To Eliminate Duplicate Efforts and To Achieve Cost Savings

NAVY INTEGRATED TESTING

- **Integrate Planning, Resourcing, Budgeting and Execution Across Combat System Variants and Associated Elements**
  - **No Longer Planned Independently by Each Program Office**
- **Optimization Efforts Include:**
  - **Maximize Combat System Ship Qualification Test (CSSQT) Resulting in Less DT, OT**
  - **Leverage Other Ship Class Combat System Testing**
  - **Testing of Common Variant**
  - **Maximize SDTS Testing Events**
  - **Maximize Use of M&S (PRA & Other Simulations)**

LPD 17 SOLUTION TO PRA



- PRA Assessment is a Three Pronged Approach
  - Test Against Actual Ship (LPD 17)
    - Pro – Test Targets Against the Actual Ship
    - Con – Limited Firing Events,
      Cannot Fire Target Directly at Ship
  - Test Against SDTS
    - Pro – Targets and Actual Threats, Profile is Closer to SDTS
    - Con – Limited Representation of the Actual Ship,
      Limited Firing Events
  - Test Using M&S (LPD 17 PRA Testbed)
    - Pro – Can Runs Numerous Threats, Scenarios, Events
    - Con – Developmental Cost & Time, Limiting Assumptions

OPTIMIZED TESTING – LPD 17

- **CSSQT**
  - Combat System Ship Qualification Testing (Prove Out the CS)
  - Maximize Use of Detect to Engage Sequence to Satisfy DT/ OT Requirements
  - Help Resolve PRA Measure of Effectiveness (MOE)
- **Lead Ship/ Operational Testing**
  - Tracking Exercises
  - Target Firings, Combat System Detect to Engage Sequence
  - Nulka Testing
  - Help Resolve PRA MOE
- **SDTS**
  - Target Firings, Engagement Analysis of Stressing Targets
  - Help Resolve PRA MOE
- **PRA Testbed**
  - Data Collection from Above Firings for Validation
  - PRA MOE Analysis (Testbed Accredited Specifically for PRA)
  - Feedback of Combat System Performance to Developers
  - Not Used for Preflight Predictions for Target Firings

OPTIMIZING T&E AND M&S

- The ‘Chicken and the Egg’ Dilemma
  - You Need the Data to Accredit the Testbed to Perform the Preflight Predictions for the Live Fire Events that Get the Data
- M&S Optimizes Its Use of T&E Data
  - Use Tracking and Live Fire Data for Validation
  - Integrate Validation Results Into the Testbed
  - Validate and Accredit the Testbed
- T&E Data Optimizes Its Use of M&S
  - Live Fire Events Use Stand Alone Models For Preflight Predictions
  - Testbed Runs Gain Understanding of Combat Systems Sensitivities (Not Accredited to Perform Preflight Predictions)
  - In the Future – Accredit the Testbed to Perform Preflight Predictions (Although it Needs Live Fire Data to Accredit?)

AVW TECHNOLOGIES

LPD 17 PRA TESTBED

- **Spiral Development**
  - 4 Builds Over 4 Years
- **Validation Activities**
  - Compare Event With Replicated Event In the Testbed
    - CSSQT Event
    - Lead Ship/ OT Firings, Tracking Exercises
  - Integrated Validation Data Into Testbed
- **Analysis Approach**
  - 20 PRA Events (5 Targets, 2 Geographic Locations, 2 Ship Signatures)
  - 80 Runs Per PRA Event (5 Times of Day, 8 Threat Radials, 2 Seasons)
  - One Firing for Each Unique Run

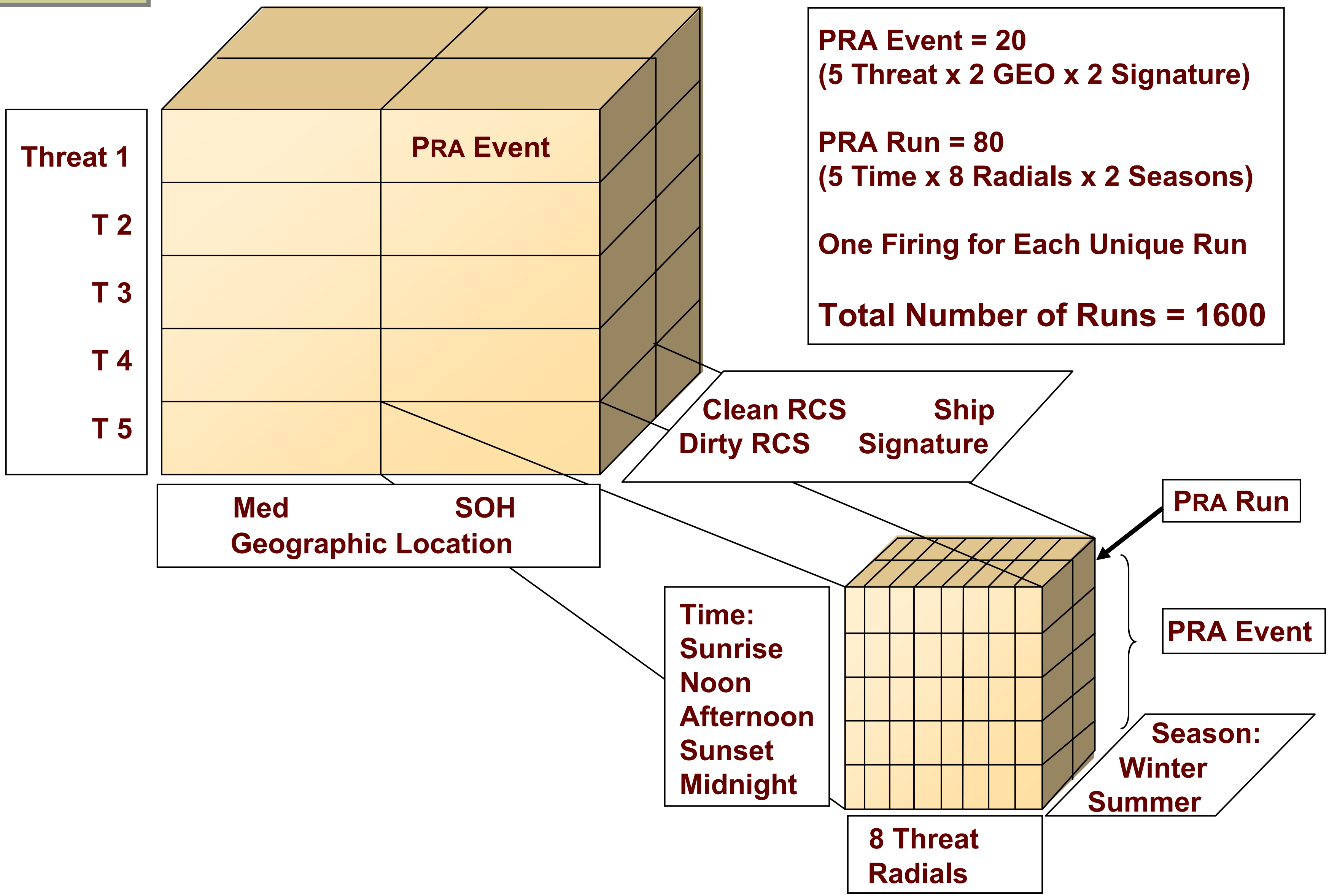
TESTBED SAMPLE SPACE

PRA Event = 20
(5 Threat x 2 GEO x 2 Signature)

PRA Run = 80
(5 Time x 8 Radials x 2 Seasons)

One Firing for Each Unique Run

Total Number of Runs = 1600



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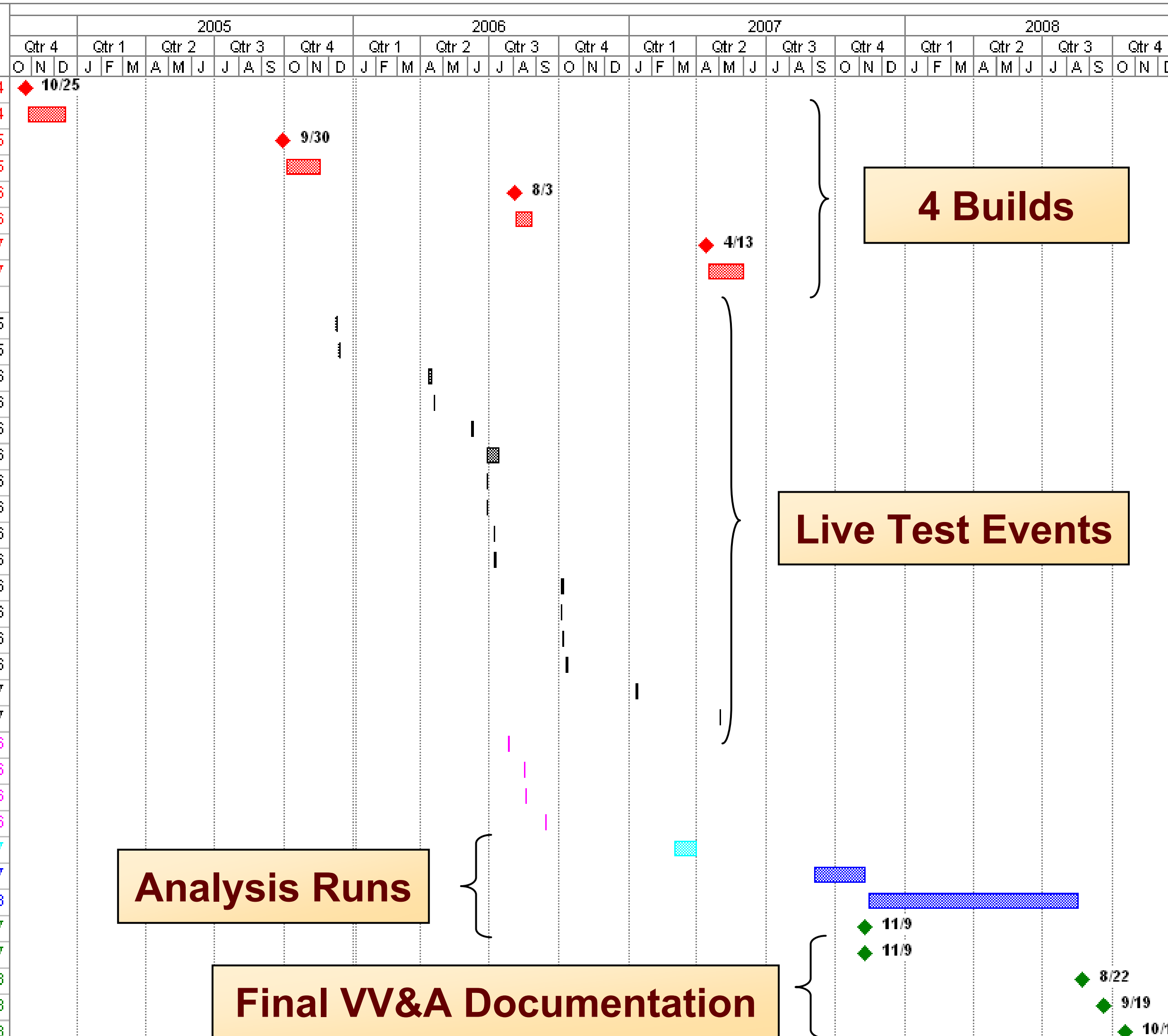


AVW TECHNOLOGIES

LPD 17 P_{RA} ORGANIZATION

MANAGEMENT IPT

- LPD 17 Combat System Integration Manager
- LPD 17 Test Director
- Ship Self Defense Combat Systems Engineer
- Deputy SSD CSE

WORKING IPT

- Development
- VV&A
- Integration
- Test Planning

SIMULATION CONTROL PANELS (SCP)

- Threat
- Softkill
- Radars
- Natural Environment
- Hardkill
- CEC
- Scenario
- Test Bed
- SSDS

CS Element PMs →

← M&S Developers

ROLES & RESPONSIBILITIES

- PMS 317
  - Manage Funding
  - Drive Schedule
  - V&V Manager
  - DT Accrediting Authority
- PEO IWS CSE
  - Manage Testbed Design and Development
- NRL
  - Testbed Integrator
- NSWC Corona
  - Test Resource, Planning and Data Collection Agent
- Element PMs
  - Co-Chair SCP
  - Review & Approve SOWs associated with M&S Development
  - Manage/ Participate in Model Development
  - Responsible for the Credibility of their Respective Models
- Model Developers
  - Develop/ Integrate Models
- COMOPTEVFOR
  - Participates as the OT Accrediting Authority

COLLECTING VALIDATION DATA

- LPD 17 Organization
  - Dedicated Test Planning Position
    - Experienced Tester – Understands The Community
    - Knowledgeable in LPD 17 Testbed Process
- Data Collection Process
  - Supports the Generation of the Live Testing Data Needs
    - Determine What Testbed Developers Need
    - Put Needs into a Document that Live Testers Understand
  - Involved in the Actual Tests

Close Working Relationship with Live Testers
Vital in Collection of Needed Live Data

DATA COLLECTION PRINCIPLES

- Early Involvement
- Establish A Strong Working Relationship Between Developers and Testers
- Clearly Define Data Collection Needs
  - Understand What Developers Want
  - Articulate Into What Testers can Understand, Collect
- Effective Communication
  - Meetings
  - Working Documents
- Arrive at a Finalized Set of Events and Data Collection that will Support the Testbed Validation

A Case Study of T&E Data Supporting A Simulation

Questions?

BACKUP SLIDES

TESTBED DOCUMENTS

REQUIREMENTS DOCUMENT

Testbed and Model Requirements

Defined at the Beginning

TESTBED AND MODEL BUILD PLAN & REPORT

Technical Approach
Functionality Per Build
Configuration Management
Integration Plan and Report

SECM

System Engineering Conceptual Model

Illustrates Model Relationships (Links to Supporting Documents)

VERIFICATION & VALIDATION PLAN AND REPORT

Derived from the Requirements
Generated from Relational Database

AVW Process developed the Approach, Requirements and Build Plan
AVW Database Produced the Requirements and VV&A Documents

LPD 17 PRA TESTBED OVERVIEW

MANAGEMENT APPROACH:

Organization
Meetings
Documents
Schedule

TECHNICAL APPROACH:

Physics - Based
Non – Real Time
Distributed, RTI Solution
HLA Compliant
Spiral Development

SYSTEM OF SYSTEMS SOLUTION

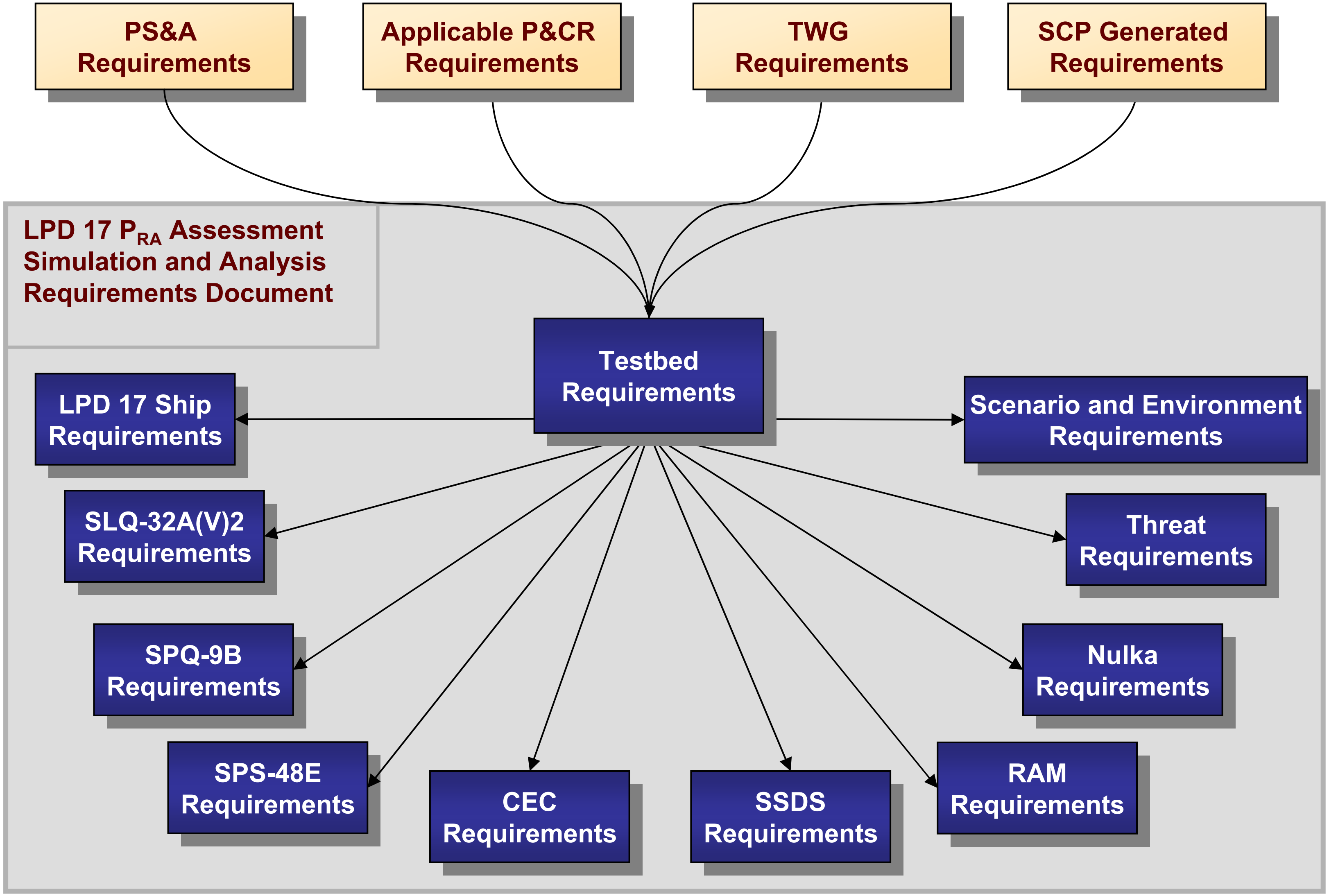
BOUND THE PROBLEM:

Testbed Requirements
Fidelity
Ship Configuration
Environment
Threat Types

BOUND THE ANALYSIS:

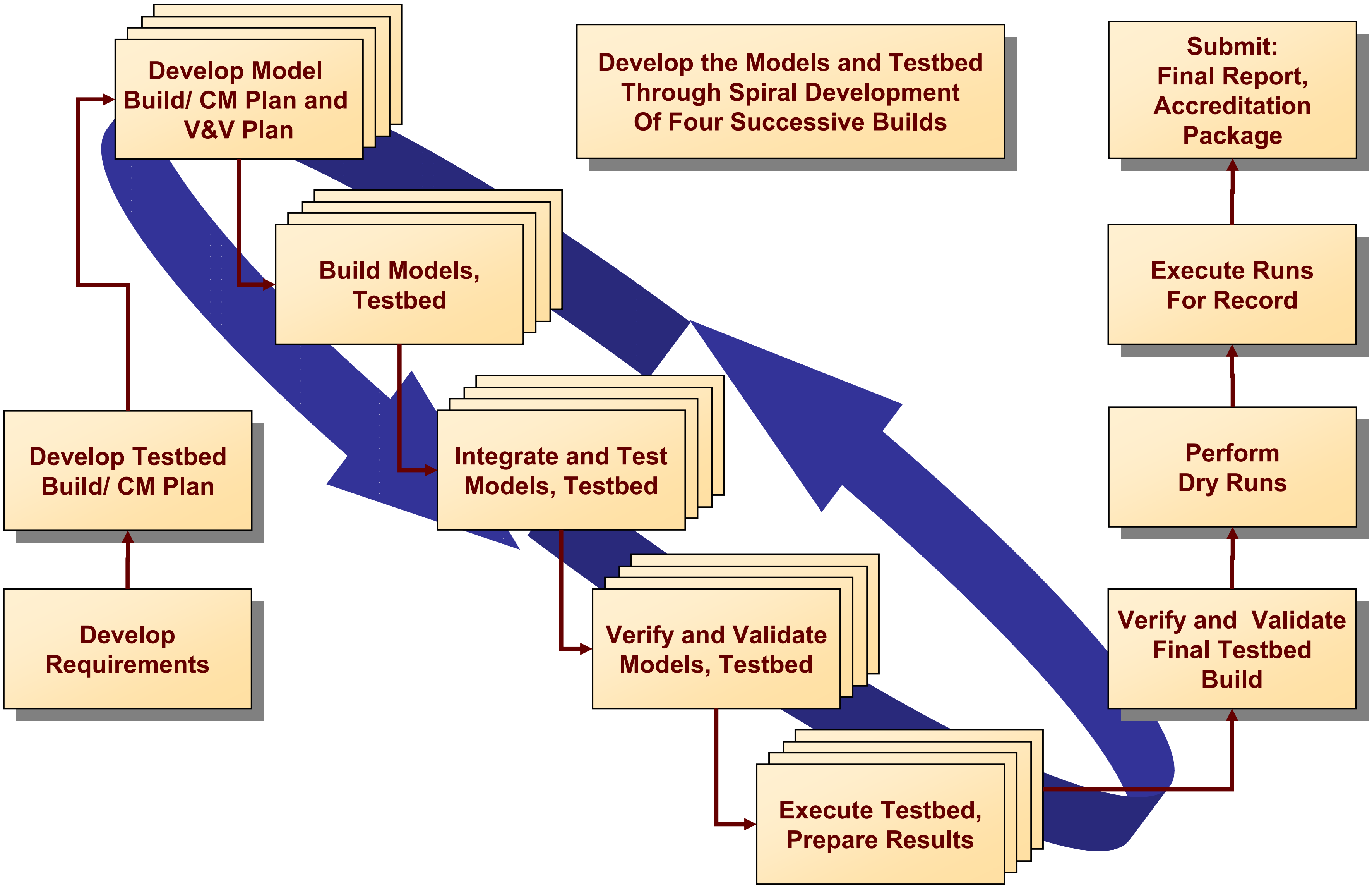
Finite Number of Runs
f(Geographic Location
Ship Configuration
Season, Time of Day
Threat Types)

TESTBED REQUIREMENTS FLOW

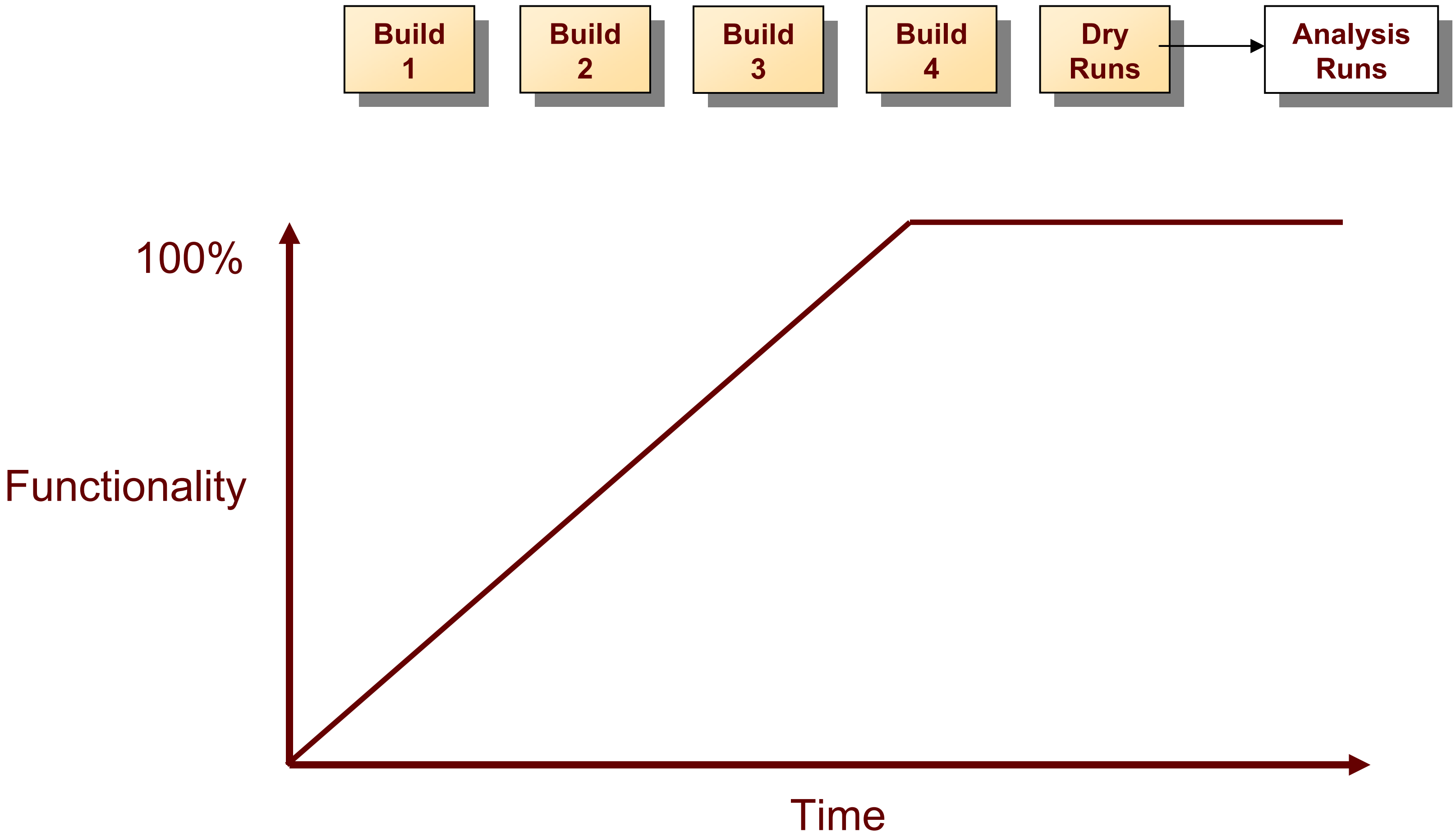


AVW TECHNOLOGIES

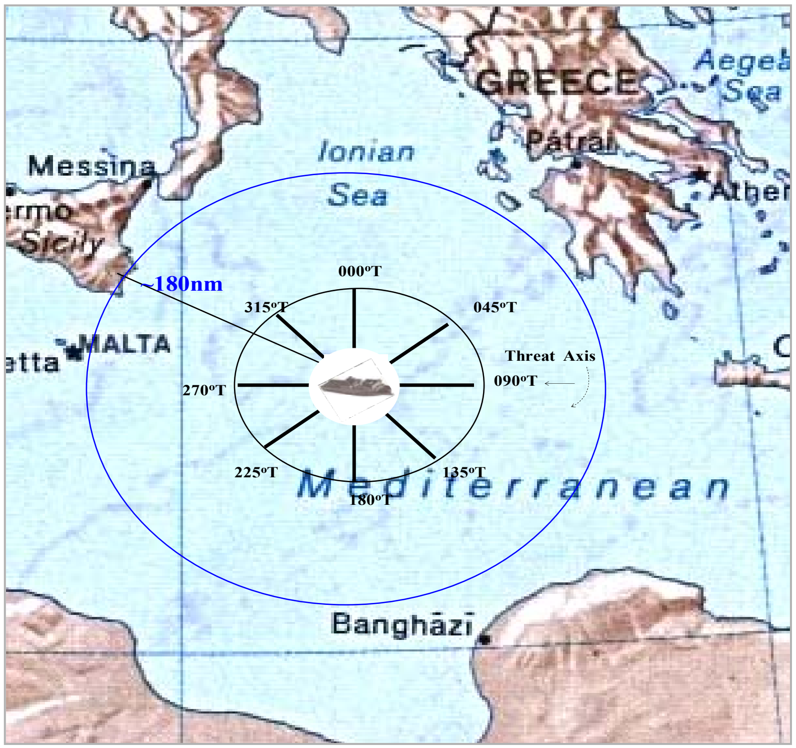
TESTBED SPIRAL DEVELOPMENT



DEVELOPMENT TIMELINE



SCENARIO - GEOGRAPHIES



Geography 1
Open Ocean - Mid-Med

Geography 2
Straits of Hormuz

ANALYSIS APPROACH

- 2 Geographies
  - Med Open Ocean
  - Straits of Hormuz
  - Provides Stressing and Non-Stressing Locations
- 2 Environments
  - 2 Times of Year
  - 5 Times of Day
  - No Rain
  - Provides Nominal Changes in Environment
- 2 Radar Cross Sections
  - Clean, Minimized RCS
  - Dirty, open well, helo on deck
  - Provides Large and Small Signatures
- 5 Threats
  - T1R1, T2, T3, T5, T7
  - 8 Threat Bearings
  - 45 Deg Intervals
  - Provides Combat System Performance from all Directions

PERFORM ONE RUN FOR EACH COMBINATION OF 6 VARIABLES STATISTICALLY A REPRENTATIVE SAMPLING THROUGH THE SPACE

TESTBED PRA CALCULATIONS

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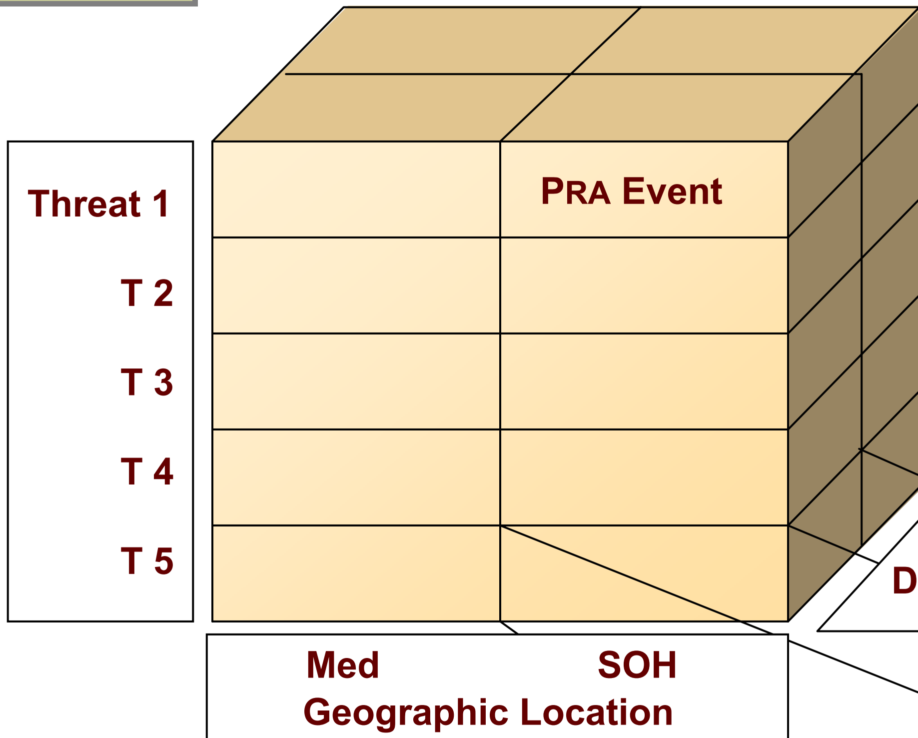

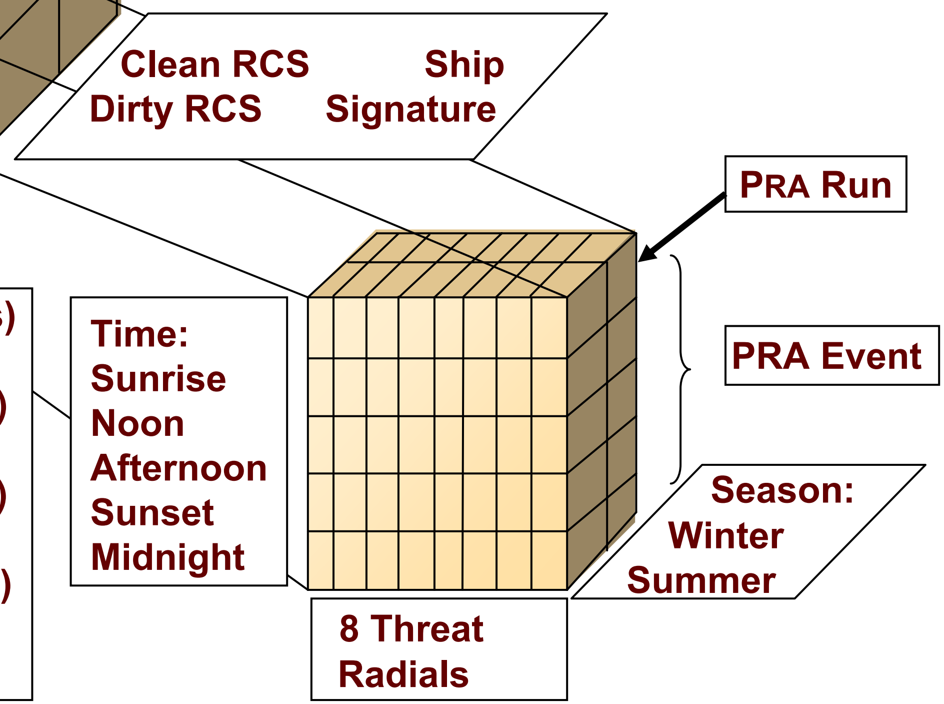

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2005 2006 2007 2008

10/25 4/13 11/9 11/9 8/22 9/19 10/17

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Analysis Runs

LPD 17 PRA Testbed VV&A Database: A Disciplined Approach for VV&A

Vincent M. Ortiz

AVW Technologies

9 March, 2006

VV&A DATABASE OVERVIEW

- An Example of Making VV&A Work
- The Simulation
- The Simulation Development Process
- The VV&A Approach
- The VV&A Process
- The VV&A Database

VV&A DATABASE OVERVIEW

- **An Example of Making VV&A Work**
  - **Have Completed Build 2 of the 4 Build LPD 17 Probability of Raid Annihilation (PRA) Testbed**
  - **Have Successfully Integrated the VV&A Process into the Development Cycle**
  - **The Documentation is Tracked via a Relational Database**
- Describe the Simulation
- Describe the Simulation Process
- Describe the VV&A Approach
- Describe the VV&A Process
- Describe the VV&A Database

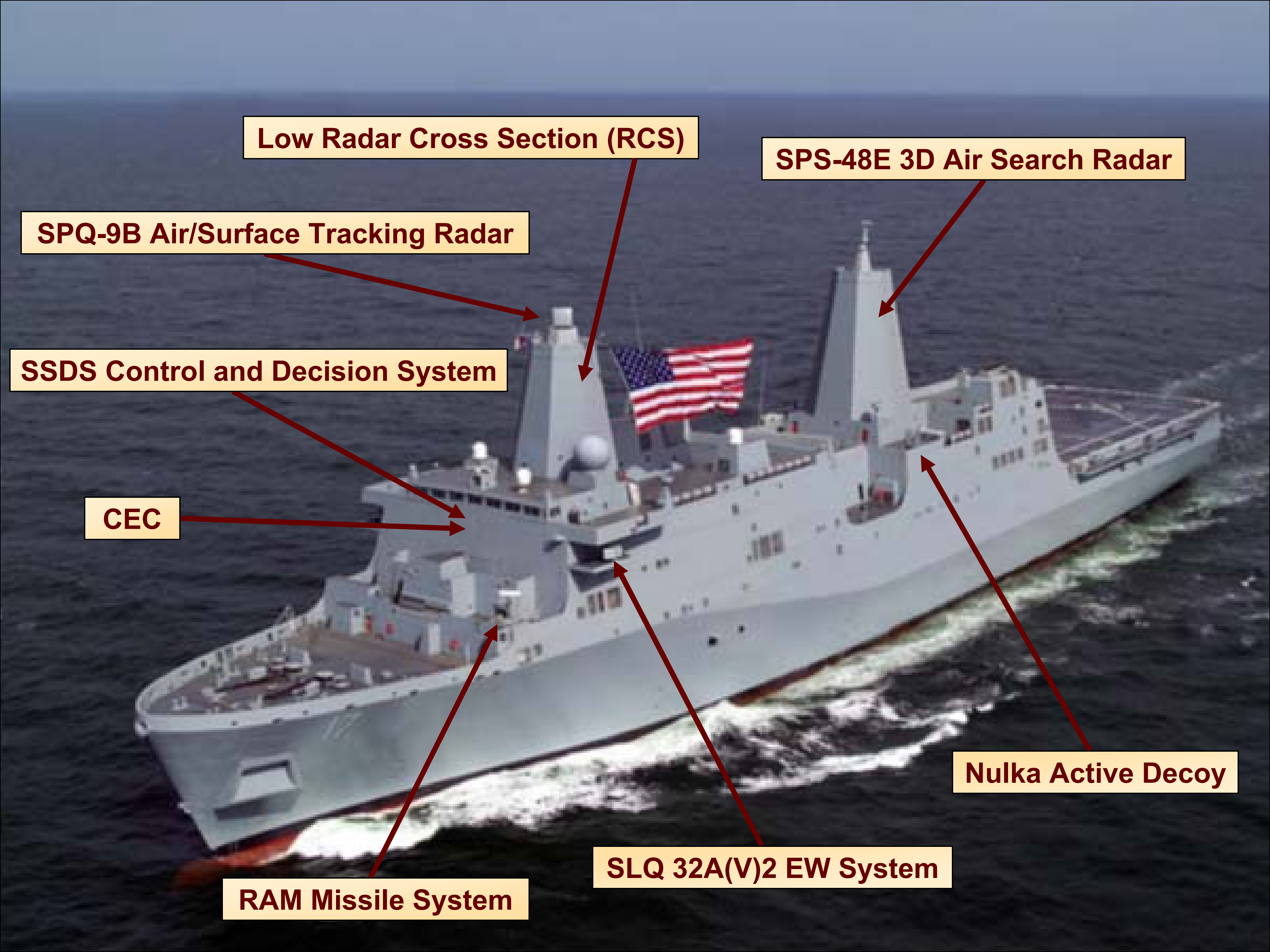
VV&A DATABASE OVERVIEW

- An Example of Making VV&A Work
- **The Simulation**
  - **LPD 17 San Antonio Ship Class**
  - **LPD 17 Combat System**
  - **PRA Requirement Definition**
  - **LPD 17 PRA Testbed Simulation**
- **The Simulation Process**
  - **Management, Technical Approach, Bound Problem Space, Defined Analysis Approach**
- The VV&A Approach
- The VV&A Process
- The VV&A Database
- Relational Database Tables

LPD 17 CAPABILITIES

- **The LPD 17 capabilities include:**
  - State-of-the-art command and control suite
  - Advanced ship survivability features that enhance its ability to operate in the unforgiving littoral environment (low radar cross section)
  - Substantially increased landing force vehicle lift capacity (23,600 square feet of vehicle storage space),
  - Large flight deck (land 2 MV-22 or 4 CH-46) and well deck (holds 2 Landing Craft Air Cushion {LCAC})
- **The LPD 17 is the first amphibious ship designed to accommodate the Marine Corps' "mobility triad"**
  - Expeditionary Fighting Vehicle (EFV)
  - LCAC
  - MV-22 Osprey tilt rotor aircraft.

OUR FOCUS WILL BE ON THE COMBAT SYSTEM



Low Radar Cross Section (RCS)
SPS-48E 3D Air Search Radar
SPQ-9B Air/Surface Tracking Radar
SSDS Control and Decision System
CEC
Nulka Active Decoy
SLQ 32A(V)2 EW System
RAM Missile System

BACKGROUND – P_{RA}

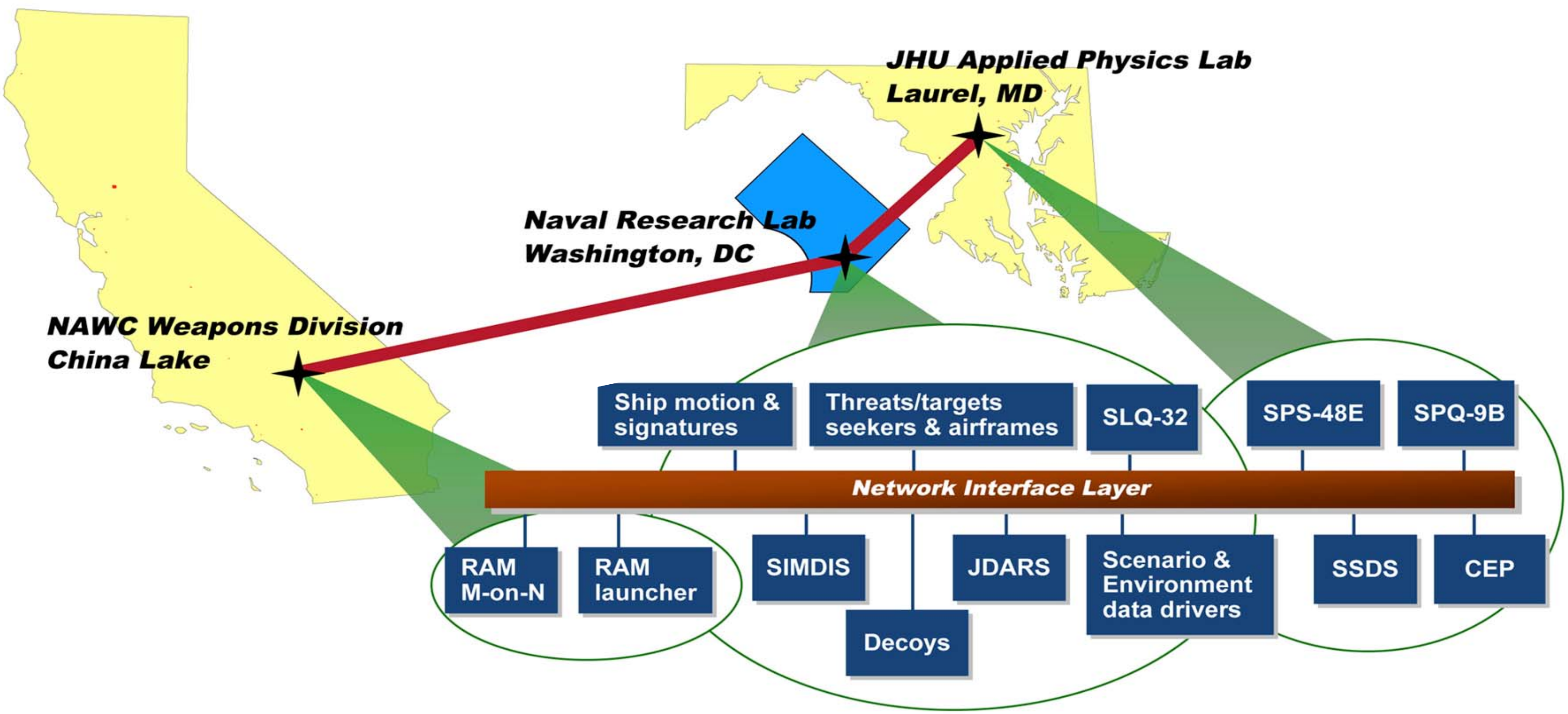
OBJECTIVE: ASSESS LPD 17's P_{RA} (ABILITY TO DEFEND ITSELF AGAINST INCOMING MISSILES)

- **CNO's Anti-Air Warfare Capstone Requirements Document mandated the ship self defense capability for specific ship classes and established the P_{RA} as the primary Measure of Effectiveness (MOE) to assess ship combat system suites.**

- **P_{RA} is defined as the ability of a particular stand-alone ship, as an integrated system, to detect, control, engage, and defeat a specified raid of anti-ship cruise missile (ASCM) threats with a specified level of probability in the operational environment.**

- **The LPD 17 class is the first U.S. naval ship class required to demonstrate its ability to defeat specific ASCM threats to achieve a specified P_{RA}.**

LPD 17 PRA TESTBED



g

Geographically Distributed Federation of Tactical HWIL, Tactical SWIL and Digital Physics Based Models

LPD 17 PRA TESTBED OVERVIEW

MANAGEMENT APPROACH:

Organization
Meetings
Documents
Schedule

TECHNICAL APPROACH:

Physics - Based
Non – Real Time
Distributed, RTI Solution
HLA Compliant
Spiral Development

SYSTEM OF SYSTEMS SOLUTION

BOUND THE PROBLEM:

Testbed Requirements
Fidelity
Ship Configuration
Environment
Threat Types

BOUND THE ANALYSIS:

Finite Number of Runs
(Geographic Location
Ship Configuration
Season, Time of Day
Threat Types)

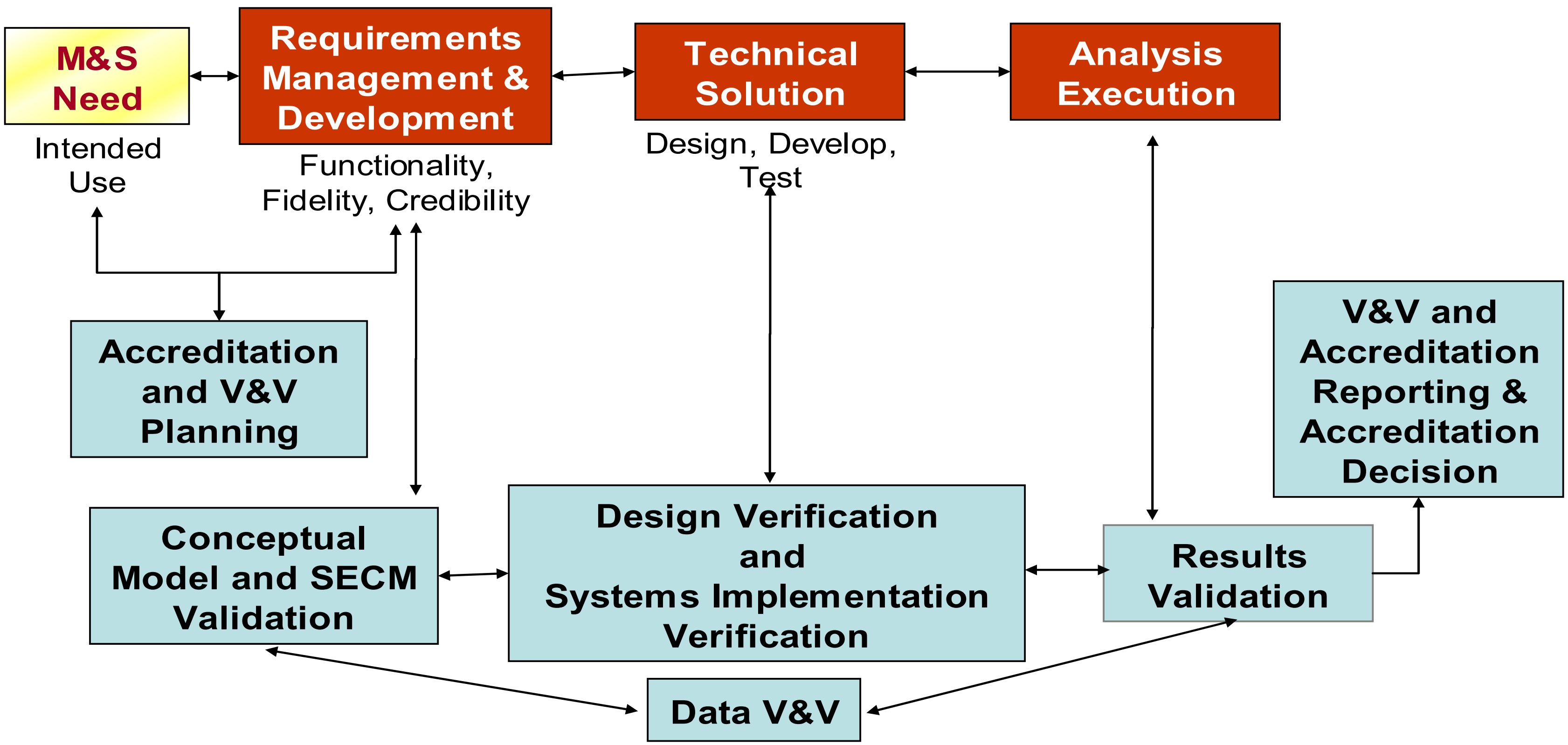
VV&A DATABASE OVERVIEW

- An Example of Making VV&A Work
- The Simulation
- The Simulation Process
- **The VV&A Approach**
  - **Set up Process with Defined V&V Checks**
  - **Leverage off of Previous Accreditation Packages, Focus on Implementation in the Testbed Simulation**
  - **Integrate V&V into the Simulation Spiral Development**
  - **Have a Dedicated V&V Team to Relieve Pressure from Developers**
- The VV&A Process
- The VV&A Database

4 PHASES of V&V AND CHECKS

- As Defined in the DOD M&S Recommended Practices Guide (RPG)
- 1. Conceptual Model (and SECM) Validation
  - Conceptual Model – Testbed Design and Architecture
  - SECM – System Engineering Conceptual Model Document
- 2., 3. Functional Design and System Verification
  - Combine Functional Design Verification Step with The System Verification Step
  - Verify Data within the Models
- 4. Results Validation
  - Use Live Test Data to Validate Testbed Performance
- Data Verification
  - Defined as Environmental, Scenario, and FOM Data

LPD 17 PRA M&S AND VV&A PROCESSES



4 PHASES of V&V - STEP 1

- Conceptual Model and SECM Validation
  - Conceptual Model Validation
    - Review Individual Models Ability to Satisfy Requirements
    - Review Model's Role, Interactions Within the Testbed
  - System Engineer Conceptual Model Validation
    - Review Universal Modeling Language Representation
    - Review Input, Output Flows For Each Model
  - Trace Requirements to Models, Model Elements

4 PHASES of V&V - STEP 2/3

- **Functional Design and System Verification (Partial Listing)**
  - HW Architectural Design Review
  - Design Review of Rehosted Tactical Code
  - Algorithm and Structure Control Flow
  - Evaluate Interfaces
  - Model Input/Output Visualization
  - Model Element Black Box Functionality
  - SME Model to Testbed Input/Output Comparison
  - Verify Input Data/ Output Data as Appropriate
  - Trace Requirements into Design
  - Model Performance Compliance

4 PHASES of V&V - STEP 4

- Results Validation
  - Display Model Execution
  - Model Output Data – Format and Fidelity
  - Operationally Test Model for Proper Operation
  - SME Comparison of Model to Actual System
  - Test Federation Requirements
  - Validate Model Output Using Real-World Input Data
  - Trace Requirements to Model Performance
  - Model Performance Compliance

4 PHASES of V&V

- Data Verification
  - Assess Environmental Data
    - Verify Transformation/ Data Consistency
    - Verify/ Validate Data and Metadata
    - Verify/ Validate Initialization Data
  - Assess Scenario Data
    - Verify Transformation/ Data Consistency
    - Verify/ Validate Scenario Data Set
    - Verify/ Validate Data and Metadata
  - Assess FOM Data
    - Graphical Comparison
    - Verify Object Attributes and Structure
    - Verify Interaction Parameters and Data Types

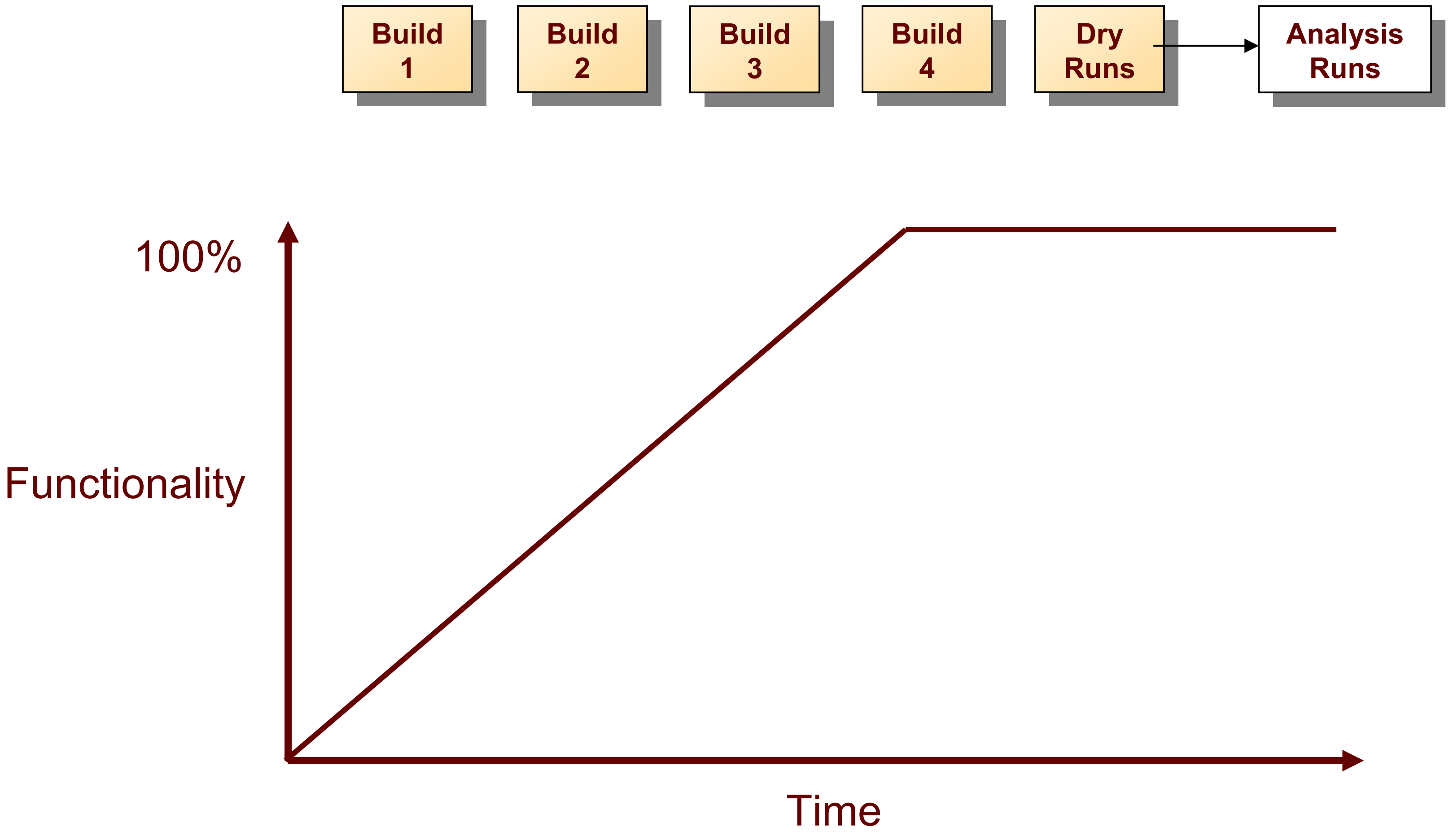
LEVERAGE PREVIOUS VV&A

- Review Model's Previous Accreditation Package
  - For Model Credibility
  - For Applicability to Testbed
- VV&A Team Focus
  - The Model as it is Used Within the Testbed
  - Integration of the Model Within the Testbed
  - Model Interfaces Within the Testbed

V&V AND MODEL DEVELOPMENT

- LPD 17 PRA Testbed Spiral Development Approach
  - Four Builds Over 3 Years
  - Increasing Functionality Within Each Build
- V&V Integration
  - Identify V&V Checks That Can Be Performed During the Builds
  - Perform Checks at the Completion of Each Build

DEVELOPMENT TIMELINE



LPD 17 P_{RA} ORGANIZATION

AVW TECHNOLOGIES

MANAGEMENT IPT

- LPD 17 Combat System Integration Manager
- LPD 17 Test Director
- Ship Self Defense Combat Systems Engineer
- Deputy SSD CSE

WORKING IPT

- Development
- VV&A
- Integration
- Test Planning

SIMULATION CONTROL PANELS (SCP)

- Threat
- Softkill
- Radars
- Natural Environment
- Hardkill
- CEC
- Scenario
- Test Bed
- SSDS

CS Element PMs →

← M&S Developers

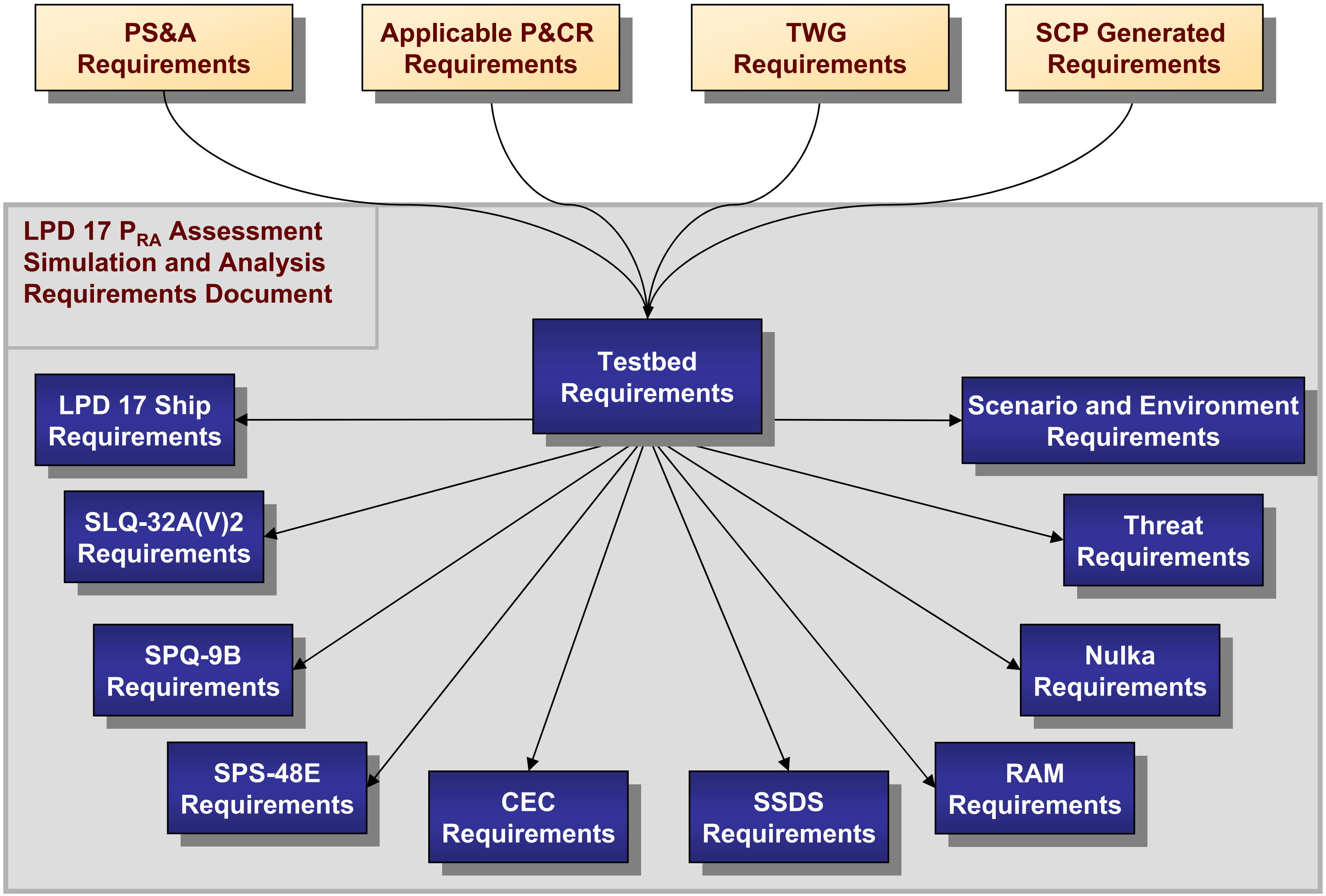
VV&A ORGANIZATION

- Separate Team From Developers
  - Experienced in Combat Systems and Ship Operations
  - Knowledgeable in Verification and Validation Process
- V&V Philosophy
  - V&V Team Perform the V&V Checks (with Assistance of the Developers as Necessary)
  - V&V Checks Performed During Each Build as the Testbed Functionality Permits
  - V&V Team Generates the Documentation
  - Minimizes the Workload on the Developers

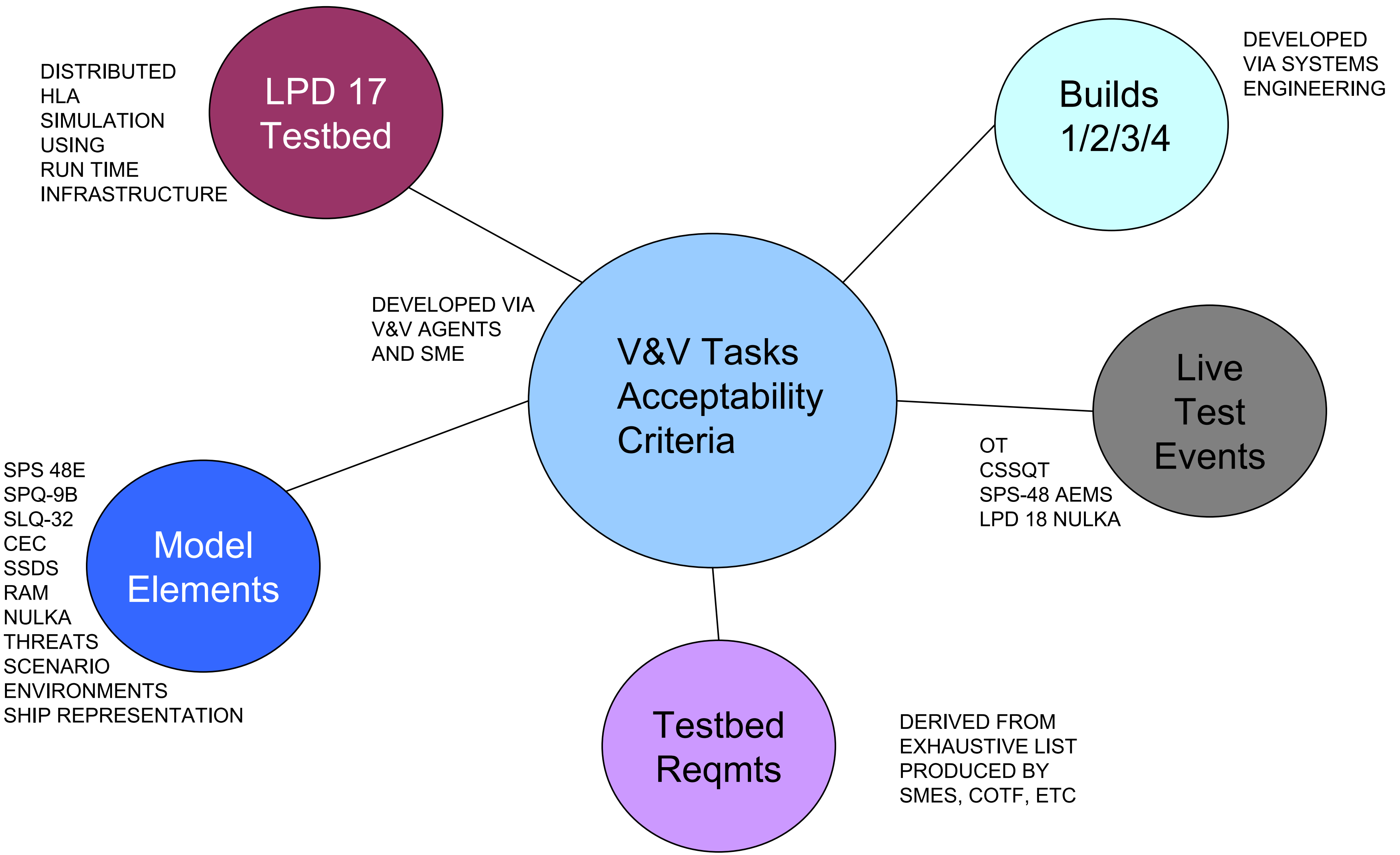
VV&A DATABASE OVERVIEW

- An Example of Making VV&A Work
- The Simulation
- The Simulation Process
- The VV&A Approach
- **The VV&A Process**
  - **Requirements is the Foundation, (there are over 1600 for this Federation)**
  - **Arrange Requirements under Models, Builds**
  - **Assign V&V Checks, Acceptability Criteria to Each Requirement**
  - **Perform V&V During Each Build**
  - **Generate V&V Reports**
- Describe the VV&A Database

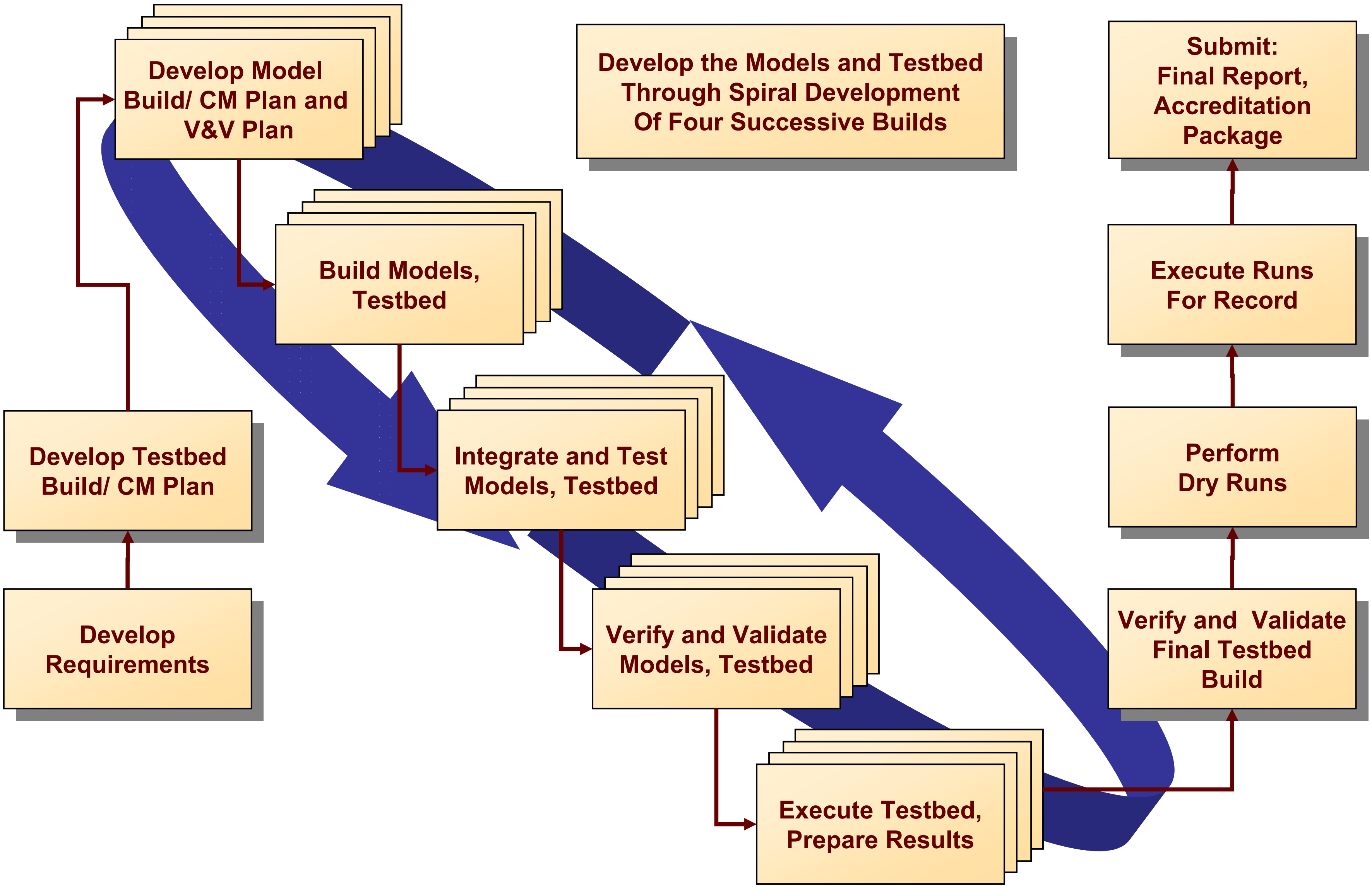
TESTBED REQUIREMENTS FLOW



DATABASE: VV&A TASKS AND ACCEPTABILITY CRITERIA VIEW



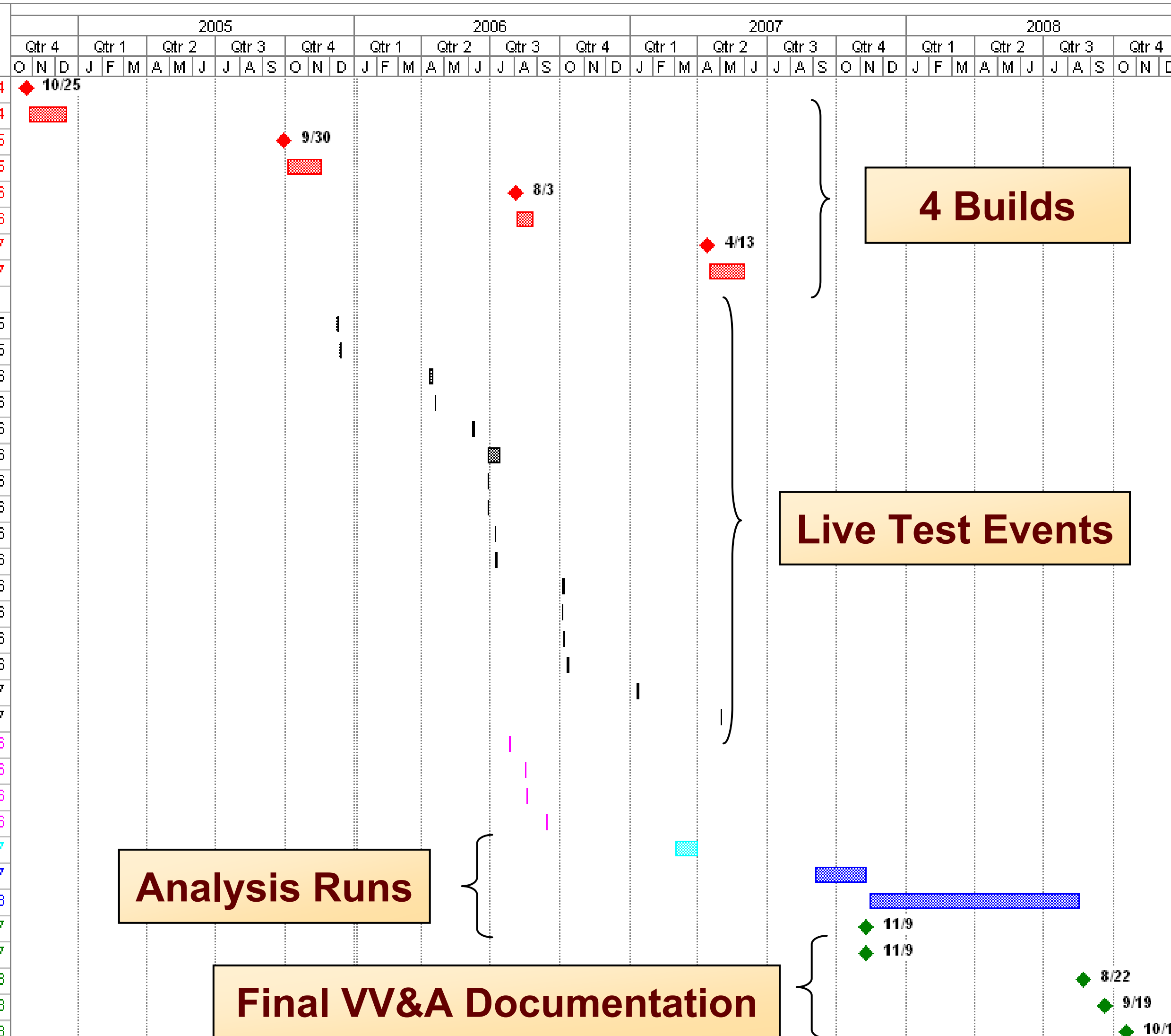
TESTBED SPIRAL DEVELOPMENT



AVW TECHNOLOGIES

TESTBED SCHEDULE

ID	Task Name	Start	Finish
1	Model Build 1	Mon 10/25/04	Mon 10/25/04
2	Testbed Build 1	Tue 10/26/04	Wed 12/15/04
3	Model Build 2	Fri 9/30/05	Fri 9/30/05
4	Testbed Build 2	Mon 10/3/05	Wed 11/16/05
5	Model Build 3	Thu 8/3/06	Thu 8/3/06
6	Testbed Build 3	Fri 8/4/06	Thu 8/24/06
7	Model Build 4	Fri 4/13/07	Fri 4/13/07
8	Testbed Build 4/Final	Mon 4/16/07	Thu 5/31/07
9			
10	SSDS TE #1	Thu 12/8/05	Sat 12/10/05
11	SPS-48E Characterization Testing	Mon 12/12/05	Tue 12/13/05
12	SSDS TE #2	Mon 4/10/06	Fri 4/14/06
13	SESEF/SEMCIP	Mon 4/17/06	Wed 4/19/06
14	SSDS DTE TE #3	Mon 6/5/06	Thu 6/8/06
15	CSSQT U/W	Tue 6/27/06	Wed 7/12/06
16	A/C Trackex	Mon 6/26/06	Mon 6/26/06
17	DT/DTE	Tue 6/27/06	Tue 6/27/06
18	MSLEX (BQM 34)	Wed 7/5/06	Thu 7/6/06
19	RCSR Measurement	Thu 7/6/06	Sat 7/8/06
20	SSDS TE #4	Mon 10/2/06	Thu 10/5/06
21	A/C Trackex	Mon 10/2/06	Tue 10/3/06
22	DTE	Wed 10/4/06	Thu 10/5/06
23	DT/OT Firings	Mon 10/9/06	Thu 10/12/06
24	SSDS DTE TE #5	Mon 1/8/07	Thu 1/11/07
25	RCSR Validation	Mon 4/30/07	Tue 5/1/07
26	SDTS OP 1	Tue 7/25/06	Tue 7/25/06
27	SDTS OP 2	Tue 8/15/06	Tue 8/15/06
28	SDTS OP 3	Thu 8/17/06	Thu 8/17/06
29	SDTS OP 4	Tue 9/12/06	Tue 9/12/06
30	LPD 18 Nulka	Thu 3/1/07	Sat 3/31/07
31	Dry Runs	Mon 9/3/07	Fri 11/9/07
32	Analyis Runs	Mon 11/12/07	Fri 8/15/08
33	Draft V&V Report	Fri 11/9/07	Fri 11/9/07
34	Preliminary DT Accreditation	Fri 11/9/07	Fri 11/9/07
35	Final V&V Report	Fri 8/22/08	Fri 8/22/08
36	Final DT Accreditation	Fri 9/19/08	Fri 9/19/08
37	OT Recommendation to COTF	Fri 10/17/08	Fri 10/17/08



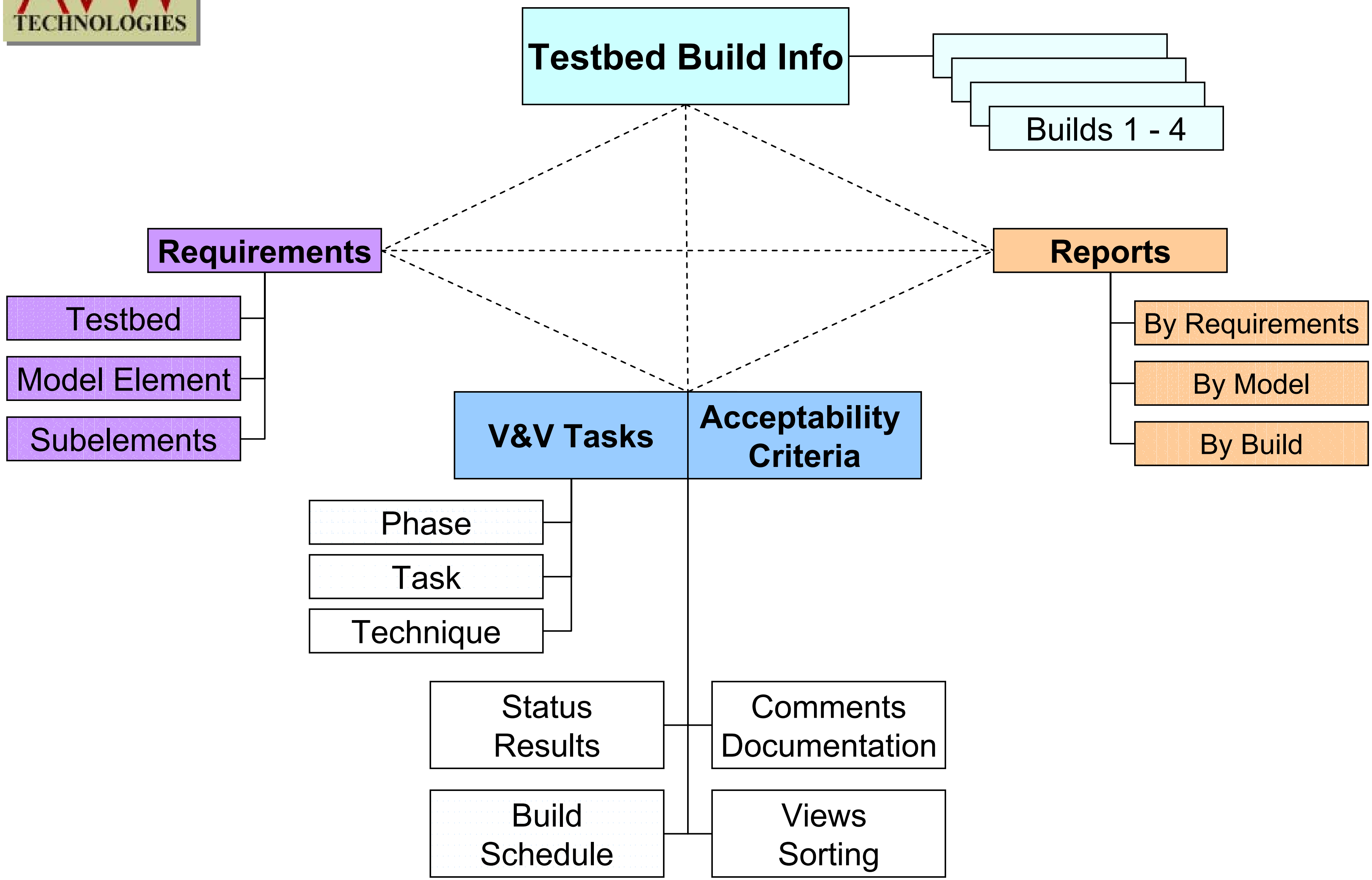
VV&A DATABASE OVERVIEW

- An Example of Making VV&A Work
- The Simulation
- The Simulation Process
- The VV&A Approach
- The VV&A Process
- **The VV&A Database**
  - **Relational Database Tables**
  - **User Interface**
  - **Database Reports That can be Generated**
  - **Program is Easily Modified, Updated.**
  - **Data, Reports is Property of the Customer**

LPD 17 PRA VV&A DATABASE

- Maps Requirements to Testbed/ Models/ Model Elements
- Maps Requirements to Builds
- Maps V&V Activities to Requirements/ Testbed/ Elements/ Subelements/ Builds
- Tracks Completion of V&V Activities
- Includes Comments/ Results/ V&V Documents
- The Database is Capable of Printing a Variety of Documents for VV&A Reports, etc.
- Uses Live Test Events for Validation

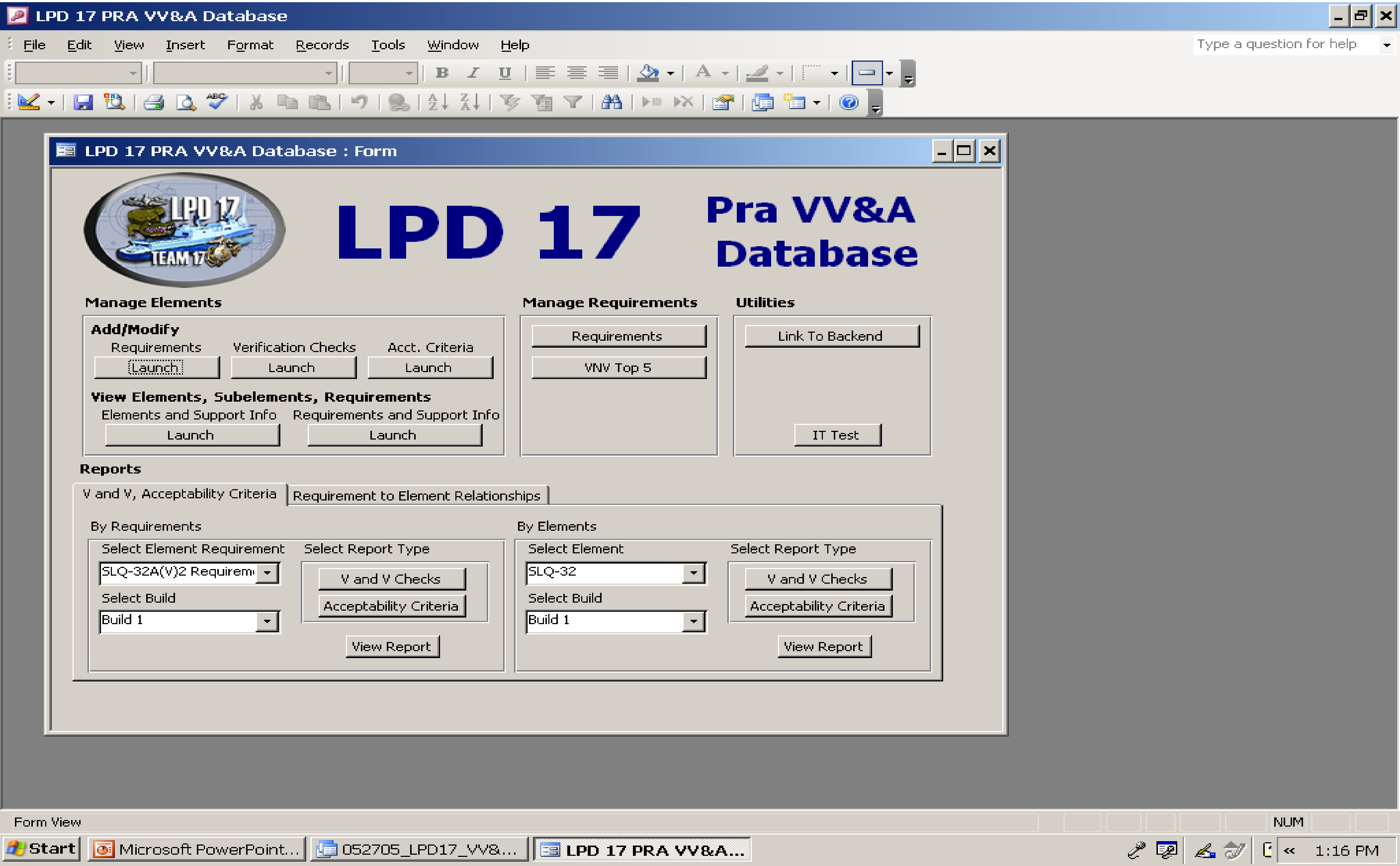
AVW VV&A DATABASE ARCHITECTURE



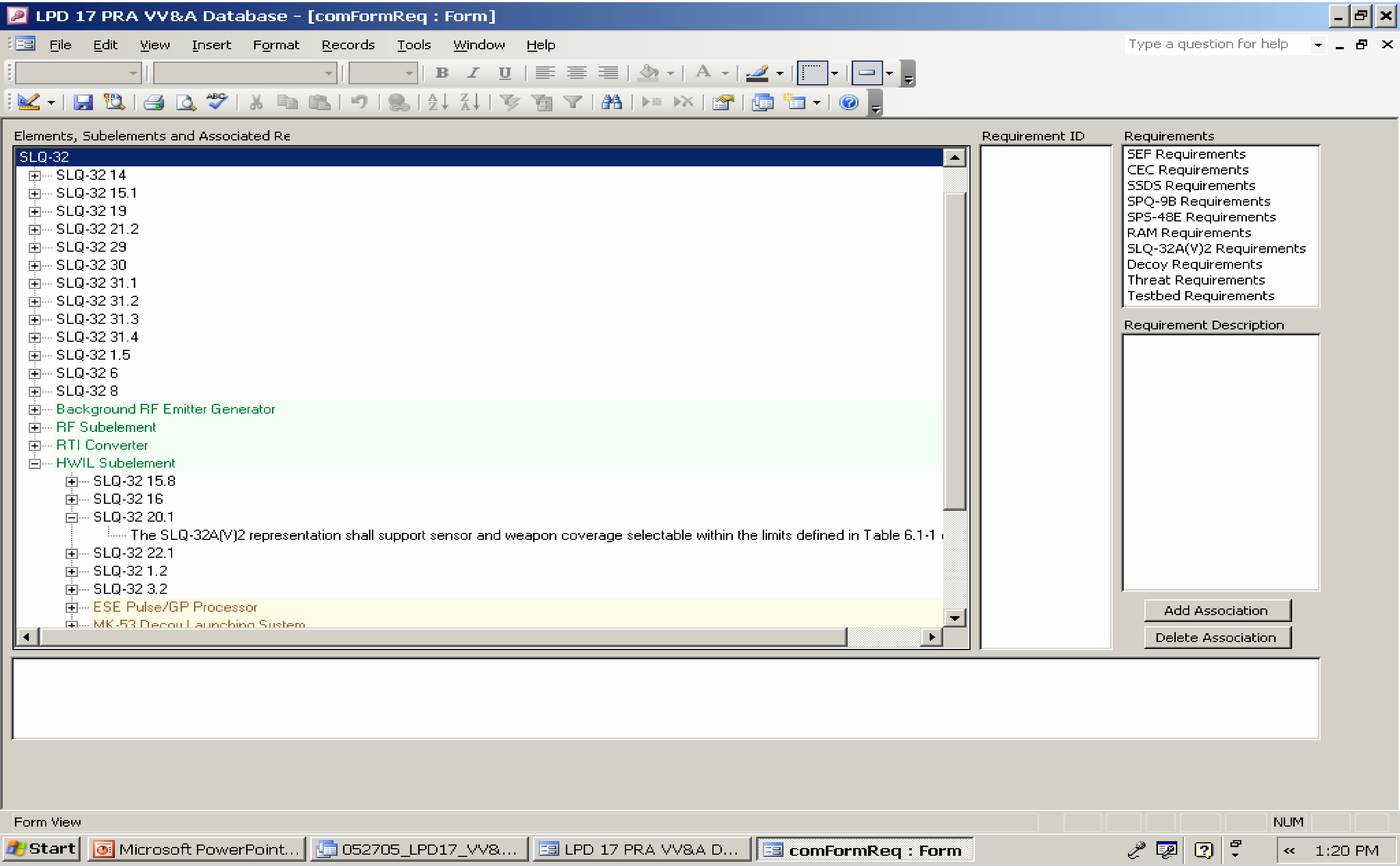
AVW VV&A DATABASE

- Microsoft Access/VBA Relational Database
  - User Friendly, Uncomplicated and Customizable
  - Low costs in License and Tech Support
  - NMCI Compatible
- Supports process standardization
  - Consistent with M&S Instructions
  - Buy in from COTF, DOT&E
- Inherent flexibility of a database
  - Reports standardization
  - Query for specific or tailored reports
- Assists COTF and PM
  - Provides quick, easy access to all information requested
  - Provides single source for requirements traceability to all VV&A efforts
  - Manages associations from requirements to development to VV&A

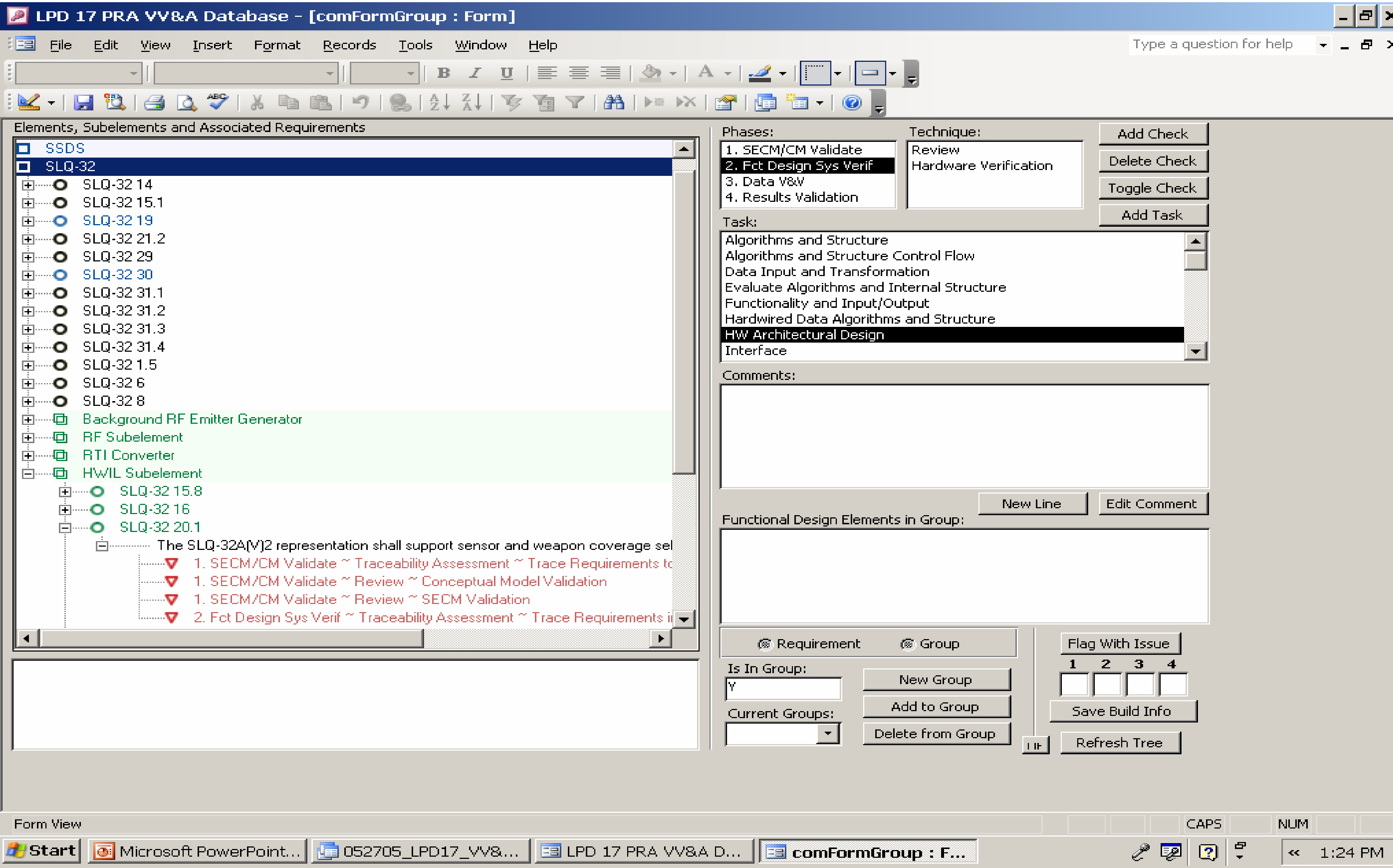
DATABASE FRONT PAGE



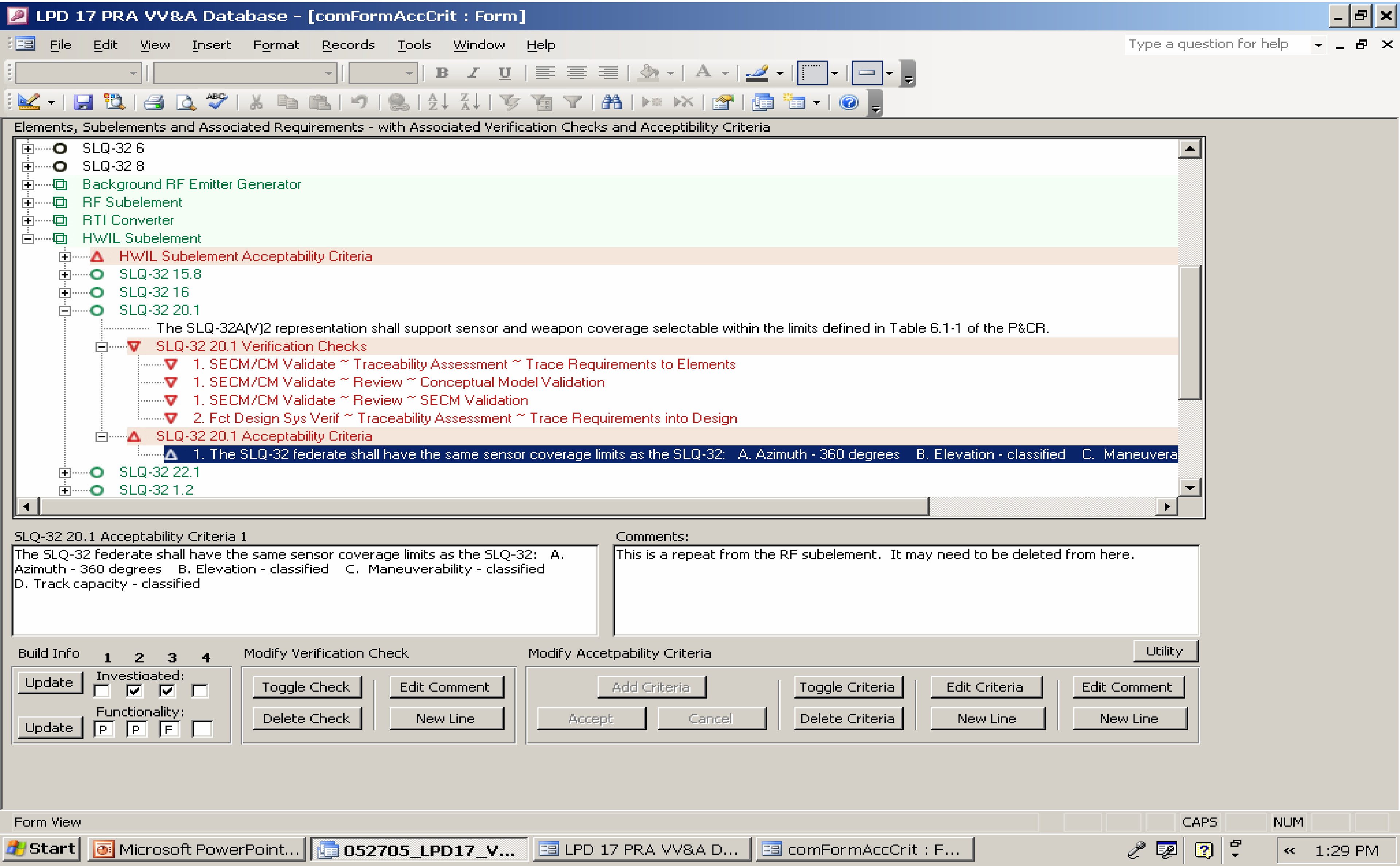
REQUIREMENTS SCREEN



V&V CHECK SCREEN

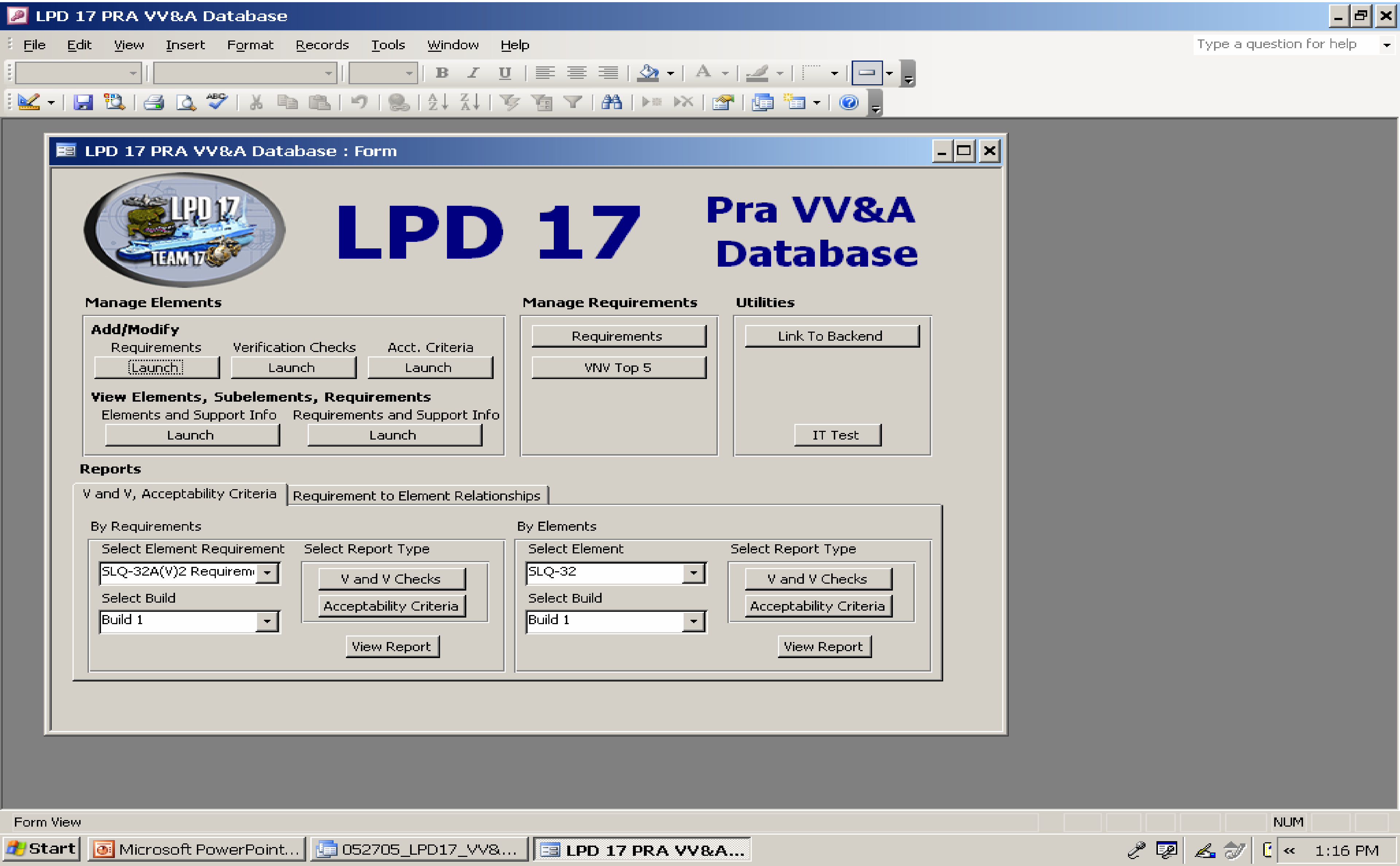


ACCEPTABILITY CRITERIA SCREEN



AVW TECHNOLOGIES

DATABASE FRONT PAGE



ACCEPTABILITY CRITERIA REPORT

AVW TECHNOLOGIES

LPD 17 PRA VV&A Database - [v2reqAccCritDetails : Report]

File Edit View Tools Window Help

Close Setup

LPD 17 PRA - VVA Database

Build 3

Acceptability Criteria: 0(0%) of 119 SLQ-32A(V)2 Requirements Acceptability Criteria met.

SLQ-32A(V)2 Requireme 0(0%) of 79 SLQ-32A(V)2 Requirements meet Acceptability Criteria.

SLQ-32 1.2

Expected Functionality: Build 1 [F] Build 2 [ ] Build 3 [ ] Build 4 [ ] — Investigated In: Build 1 [ ] Build 2 [x] Build 3 [x] Build 4 [ ]

The representation shall be capable of incorporating Sea State 3 dependent ship motion.

Requirement Acceptability Criteria: All Criteria for this requirement have not been confirmed.

Confirmation:		Criteria:	Build 1:	Build 2:	Build 3:	Build 4:
Unconfirmed	1	Verify that the SLQ-32 federation shall use the ship motion and heading as an input to the ESE via the ships synchro, and that this input is used in the computation of the SLQ-32 performance.	[ ]	[ ]	[x]	[ ]
Comment:		Kevin, how is the ship motion input used by the ESE?				
Unconfirmed	1	Verify that the SLQ-32 federation shall use the ship motion and heading as an input to the WSC 6 EMI module, and then access the lookup table to assess the degradation of the WSC-6 EMI to the SLQ-32 performance.	[ ]	[x]	[x]	[ ]
Comment:		Kevin, I am using the ship motion requirement to look at the EMI module				

SLQ-32 1.5

Expected Functionality: Build 1 [F] Build 2 [ ] Build 3 [ ] Build 4 [ ] — Investigated In: Build 1 [ ] Build 2 [x] Build 3 [x] Build 4 [ ]

The representation shall be capable of Chaff/NULKA Impact on ES capability.

Requirement Acceptability Criteria: All Criteria for this requirement have not been confirmed.

Confirmation:		Criteria:	Build 1:	Build 2:	Build 3:	Build 4:
Unconfirmed	2	Verify that the NULKA model affects the SLQ-32 model in the same manner as the NULKA affects the SLQ-32 in the actual environment using the LPD 18 NULKA testing - A. Comparing the NULKA signal that is received by the IFM and DF receivers to the SLQ-32 model. B. Comparing the NULKA signal that is processed by the ES Eprocessor to the SLQ-32 model.	[ ]	[x]	[x]	[ ]
Comment:		Kevin, do you agree with this acceptability criteria?				

SLQ-32 2

Expected Functionality: Build 1 [P] Build 2 [P] Build 3 [F] Build 4 [ ] — Investigated In: Build 1 [ ] Build 2 [x] Build 3 [x] Build 4 [ ]

All output provided by the representation shall be in a format suitable to reconstruct the run including simulation version number and input file parameters.

Requirement Acceptability Criteria: All Criteria for this requirement have not been confirmed.

Confirmation:		Criteria:	Build 1:	Build 2:	Build 3:	Build 4:
Unconfirmed	1	Verify that the SLQ-32 federate output shall be in a format suitable to reconstruct the run to include: A. Scenario files for the background emitters. B. DX from the ESE. C. SLQ-32/SSDS data collected using HLA Results. E. Version number and input file parameters.	[ ]	[x]	[x]	[ ]

Page: 1

Ready CAPS NUM

Start Microsoft PowerPoint... 052705_LPD17_VV&... LPD 17 PRA VV&A D... v2reqAccCritDetai... 1:36 PM

DECOY MODEL BUILD 2 REPORT

Monday, December 12, 2005

LPD 17 PRA – VV&A Database

Decoy Requirements Build 2

Verification & Validation Checks and Acceptability Criteria

Verification & Validation Status:
3(7%) of 46 Decoy Requirements validated. 3(1%) of 510 Decoy Requirements Verification & Validation checks validated.

Acceptability Criteria Status:
3(7%) of 46 Decoy Requirements meet Acceptability Criteria. 3(3%) of 106 Decoy Requirements Acceptability Criteria met.

Decoy 1.1 Expected Functionality: Build 1: [P] Build 2: [P] Build 3: [F] Build 4: [ ] Investigated in: Build 1: [ ] Build 2: [X] Build 3: [X] Build 4: [ ]
The Decoy representations shall be capable of incorporating various types of environmental factors regarding radar, ES, and IR performance.

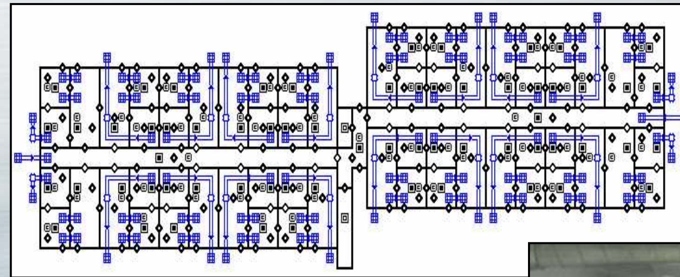
Decoy 1.1 Requirement V&V Checks All checks for this Requirement have not been confirmed.

	Element:	Phase:	Technique:	Task:	Investigated In: Build 1:	Build 2:	Build 3:	Build 4:
Unconfirmed	Threat/Decoys : EW Decoys	1. SECM/CM Validate	Traceability Assessment	Trace Requirements to Elements	[ ]	[X]	[X]	[ ]
Intent:	Trace Requirements to the Elements and Subelements.							
Comment:	Status 2/16/05 - Deferred to Builds 2/3.							
Unconfirmed	Threat/Decoys : EW Decoys	1. SECM/CM Validate	Review	Conceptual Model Validation	[ ]	[X]	[X]	[ ]
Intent:	Evaluate the conceptual model to confirm it captures the attributes and behaviors to meet the requirements.							
Comment:	Status 2/16/05 - Deferred to Builds 2/3.							
Unconfirmed	Threat/Decoys : EW Decoys	1. SECM/CM Validate	Review	SECM Validation	[ ]	[X]	[X]	[ ]
Intent:	Evaluate the SECM to confirm it captures the attributes and behaviors to meet the requirements.							
Comment:	Status 2/16/05 - Deferred to Builds 2/3.							
Unconfirmed	Threat/Decoys : EW Decoys	2. Fct Design Sys Verif	Traceability Assessment	Trace Requirements into Design	[ ]	[X]	[X]	[ ]
Intent:	Trace Requirements into the design and into the SW code and the HW.							
Comment:	Status 2/16/05 - Deferred to Builds 2/3.							
Unconfirmed	Threat/Decoys : EW Decoys	4. Results Validation	Traceability Assessment	Trace Requirements to Model Performance	[ ]	[X]	[X]	[ ]
Intent:	Trace requirements from design and systems implementation to the output.							
Comment:	Status 2/16/05 - Deferred to Builds 2/3.							
Unconfirmed	Threat/Decoys : EW Decoys	2. Fct Design Sys Verif	Functional Test	Model/ Submodel Black Box Functionality	[ ]	[X]	[X]	[ ]
Intent:	Black box testing, evaluating the accuracy of the output to input test data.							
Comment:	Status 2/16/05 - Deferred to Builds 2/3.							

SUMMARY

- A Disciplined Approach
  - Defined Management, Technical Framework
  - Consistent with M&S Guidance
- A Developed, Working Database
  - Little Cost to Adapt to a New Program
- Experienced Personnel
  - Understand the Process and the Potential Pitfalls
- Process Proven on a Complex Program
  - The Database and System Guides the Development and the V&V of the Simulation
  - An Accepted Process by COTF (Accreditation Authority) and DOT&E

BACKUP SLIDES



Integration of Transport Modeling with Test and Evaluation in CBR Building Protection Programs

NDIA 22nd Annual National Test and Evaluation Conference

James Risser

Michael Helinski

George Fenton

Battelle Memorial Institute

9 March 2006

Introduction

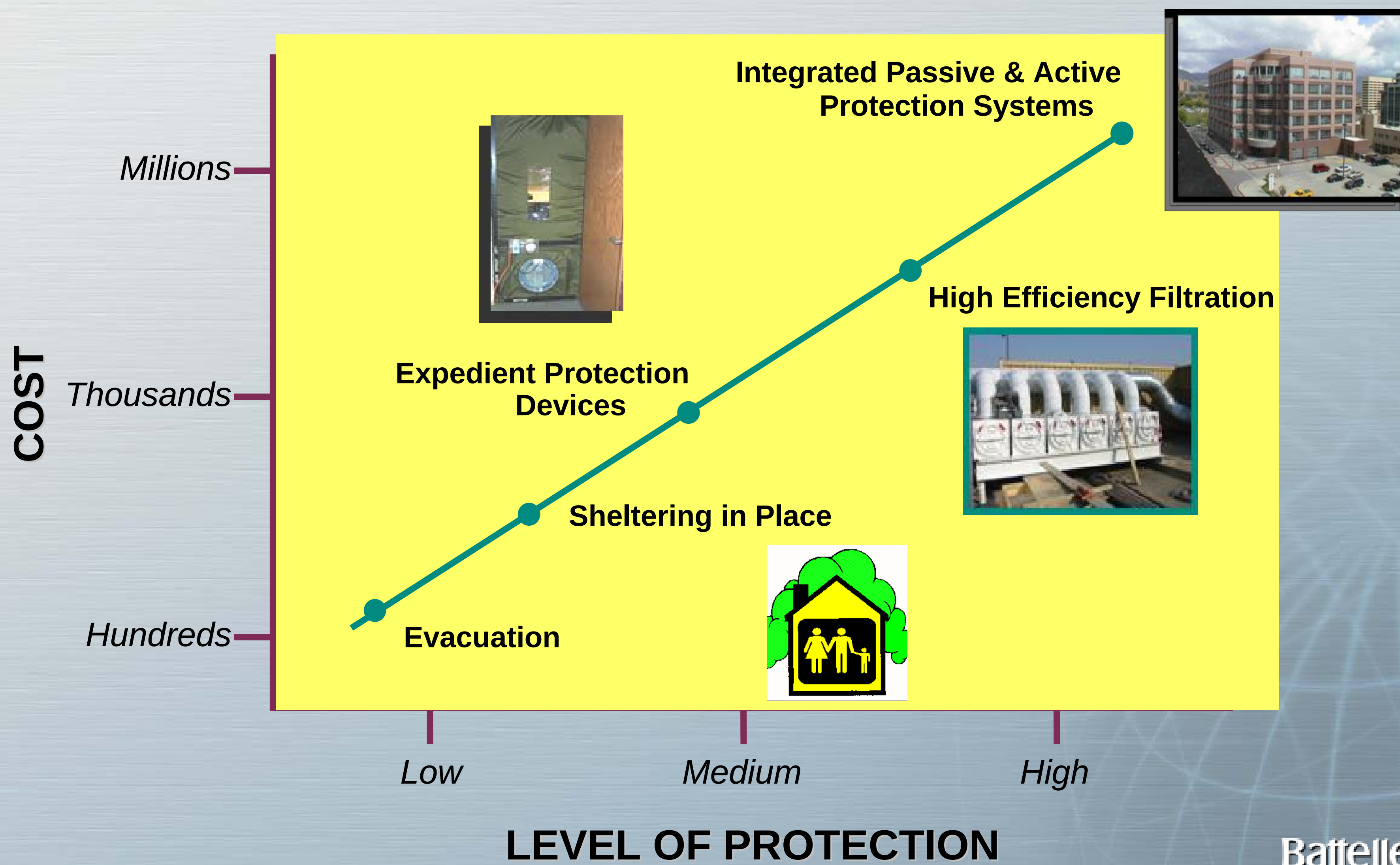
- CBR Building Protection Overview
- Role of M&S and T&E in the building protection process
- Types of models and experimentation
- Interactions between nodal modeling and contaminant transport experiments
- Example of modeling and experimental interactions and conformance analysis process
- Summary

CBR Building Protection Overview

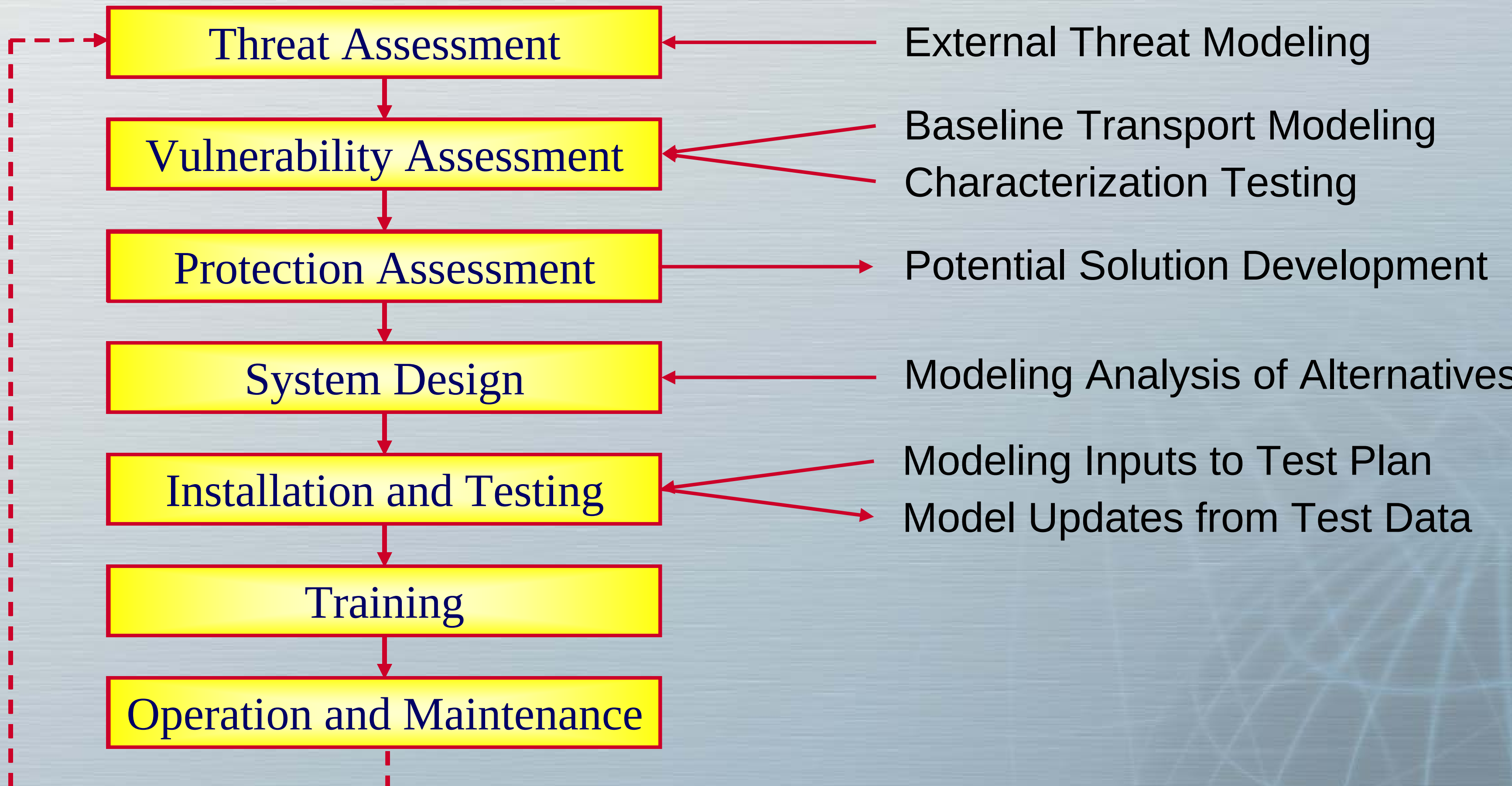
Why are buildings vulnerable to CB attack?

- Containment of CB agents within a confined space allows concentrations to rapidly reach and sustain lethal levels
- CB agents are effectively transported throughout a building by mechanical systems
- Population densities are high in buildings
- Potential to deliver agent covertly
- Numerous adsorbing surfaces that make building restoration difficult

Range of Protection Solutions



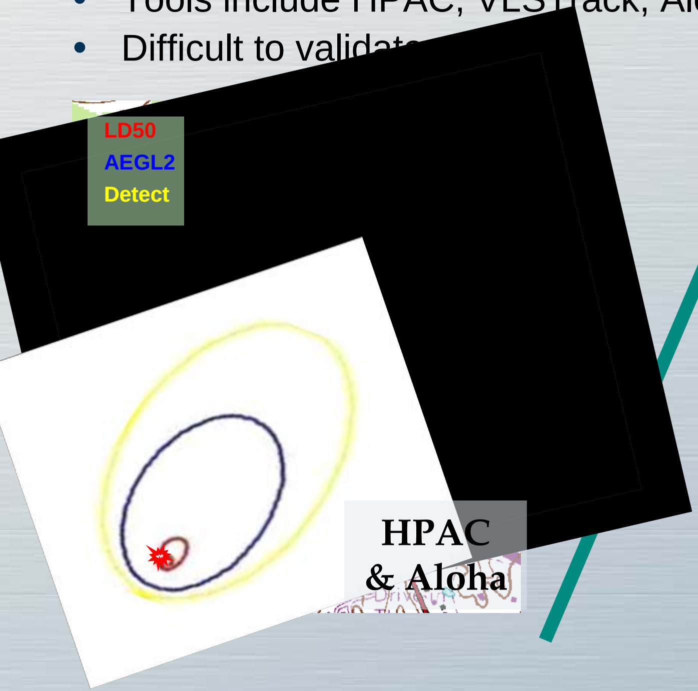
Protection System Development Process



Types of Models

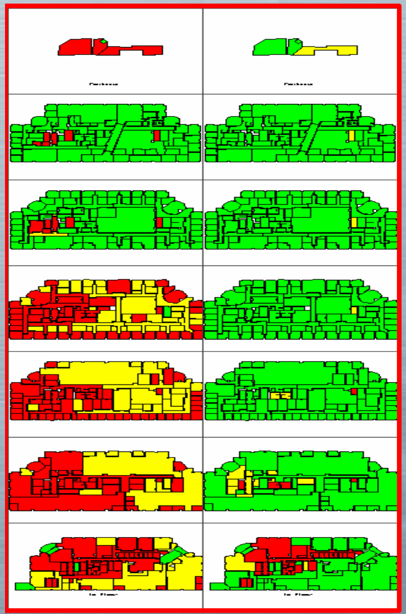
Ambient Dispersion Modeling

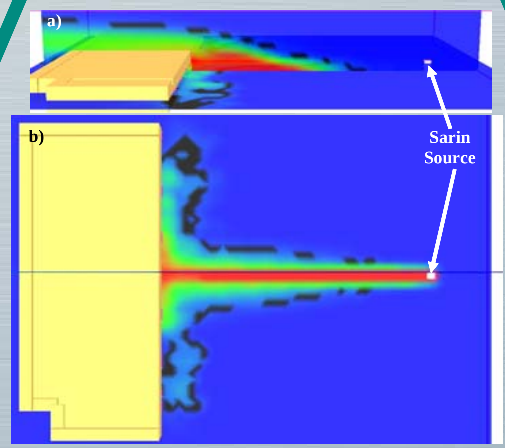
- Used to characterize external threats
- Tools include HPAC, VLSTrack, Aloha …
- Difficult to valid[redacted]



Nodal Modeling

- Used to characterize internal transport and evaluate protection system performance
- Tools include CONTAMW and COMIS
- Allows conducting numerous model runs quickly
- Validate using dosage measurements throughout building





CFD Modeling

- Used to Integrate outdoor and indoor models and to characterize flow dynamics within rooms
- Time-consuming to configure and run
- Validation requires distributed concentration vs. time measurements

Battelle
The Business of Innovation

CONTAMW Nodal Modeling

- Designed for characterization of contaminant transport though ventilated buildings
  - Utilities to simulate building HVAC systems and components
  - Libraries with representative building leakage data
  - Model output of zone concentration profiles and flow-path airflows
  - GUI for simple model construction.

Limitations . . .	**. . . Solutions**
• Well-mixed assumption inaccurate for larger building volumes.	• Break large volumes into subzones and/or correlate test data (parameterizations) with model.
• Inaccurate contaminant transport time scales.	• Correlate test data with model and/or apply CFD modeling to large volumes.
• Cannot model external releases.	• Characterize external cloud using ambient dispersion models. • Utilize CFD or parameterizations to correct for plume/building wake interaction.
• CB agent properties not fully represented.	• Post process model results with corrections derived from test data for deposition rates, release efficiencies, removal mechanisms, etc.

Modeling and Experimentation Requirements

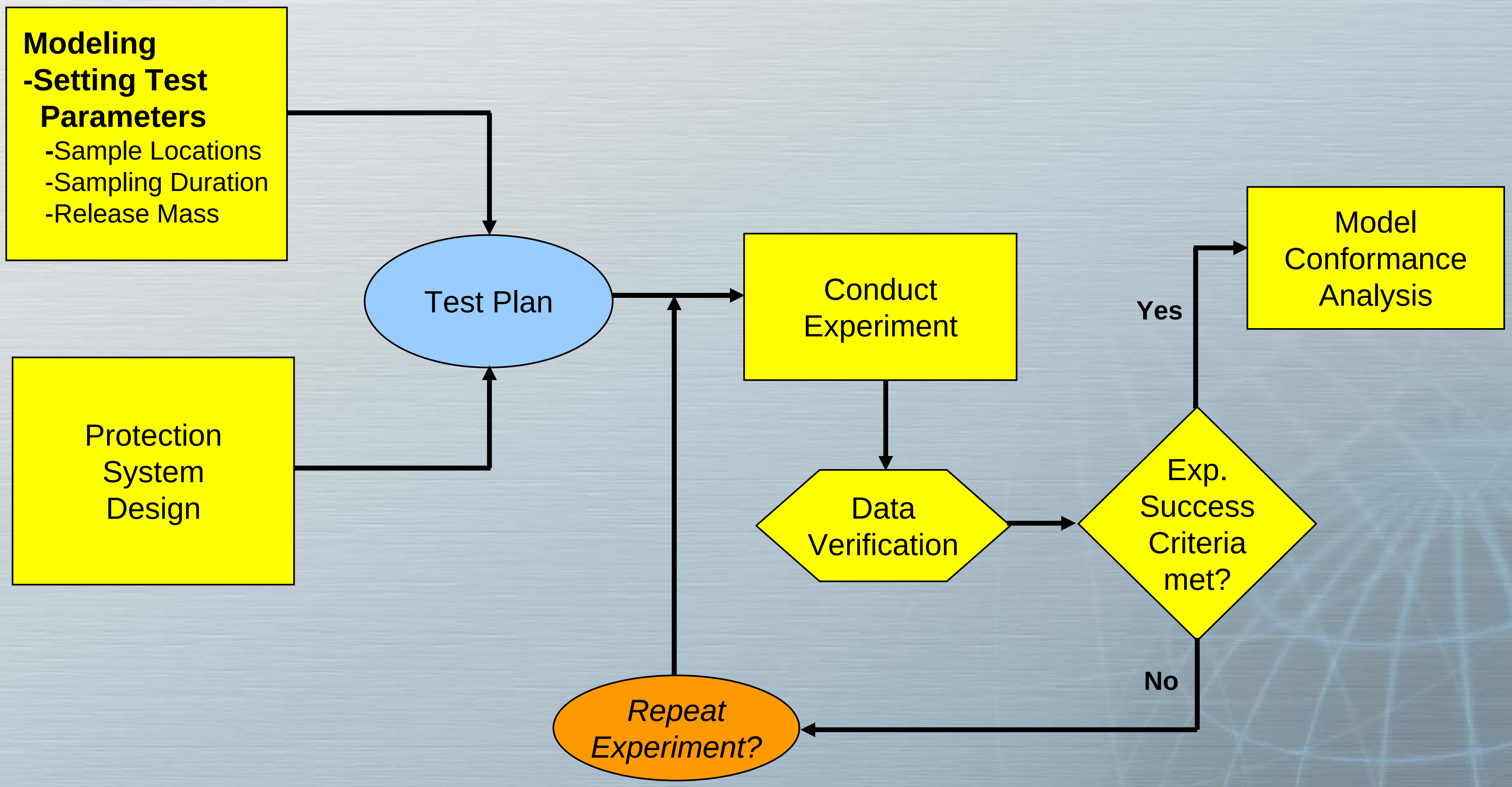
- Nodal Modeling
  - Knowledge of threat agent characteristics
  - Knowledge of building environment
  - Understanding of limitations and solutions to limitations
  - Automated post-processing
  - Experience in interpreting model results
  - Methods for modeling personnel movement
- Experimentation
  - Simulant to agent correlations
  - Controllable release mechanisms for repeatable releases
  - Sampling instrumentation, sample handling and analysis methods
  - Data analysis methods (including uncertainty analysis)







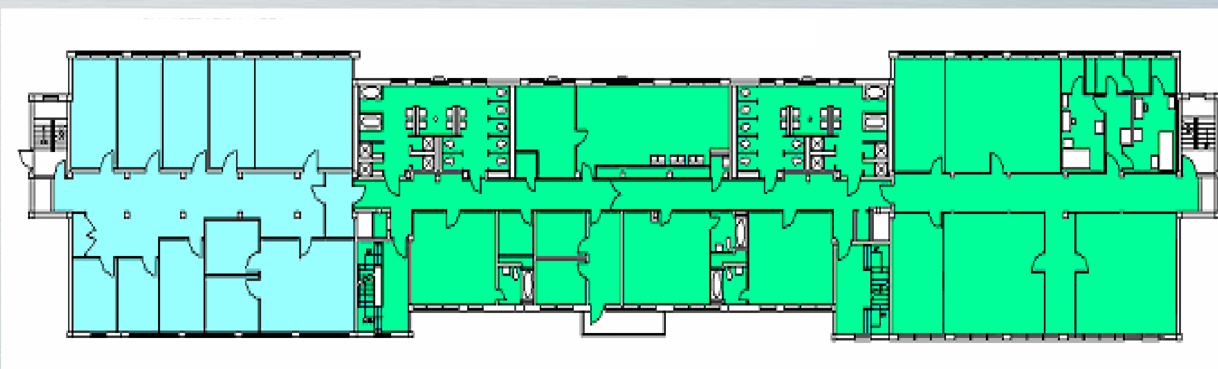
Modeling / Experimentation Process

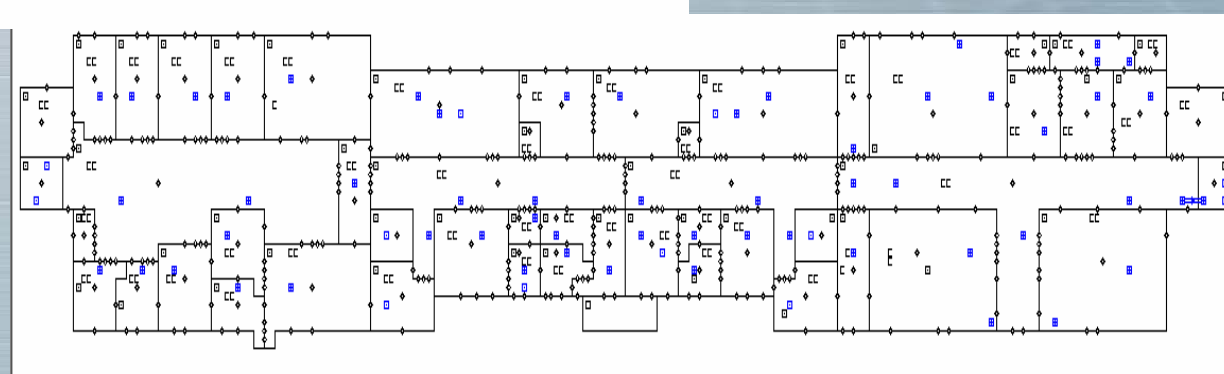


Modeling / Experimentation Process Example

Example Building

- Former military barracks, 30,000 ft^2
- Three stories with a quarter basement
- Four HVAC zones

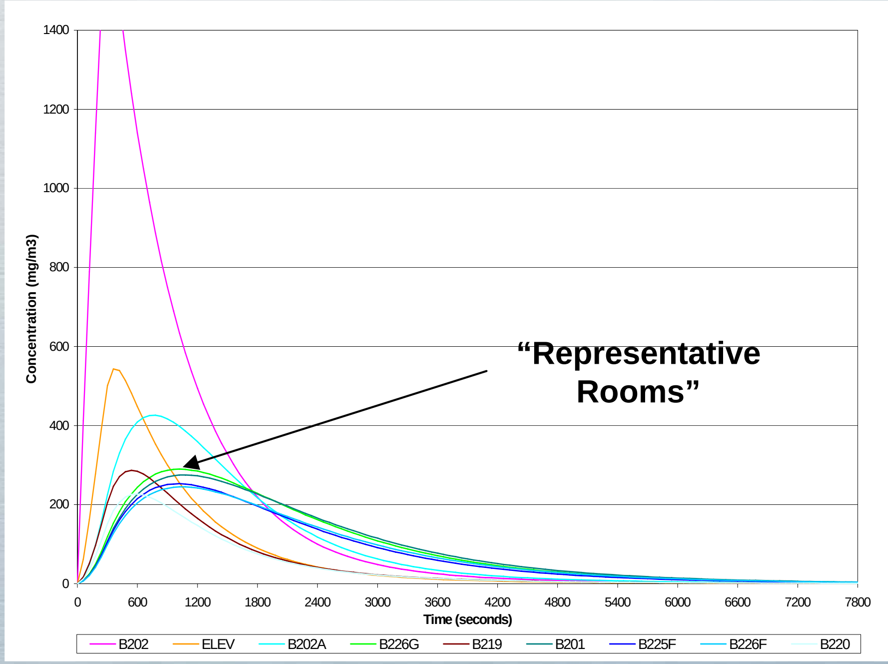


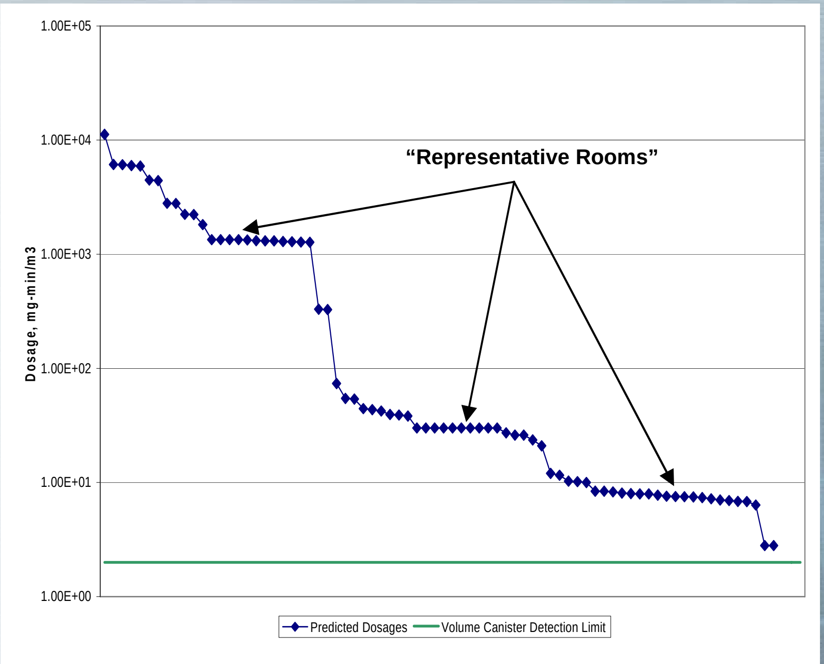


CONTAM Model Schematic

Test Parameter Selection – Sampling Locations

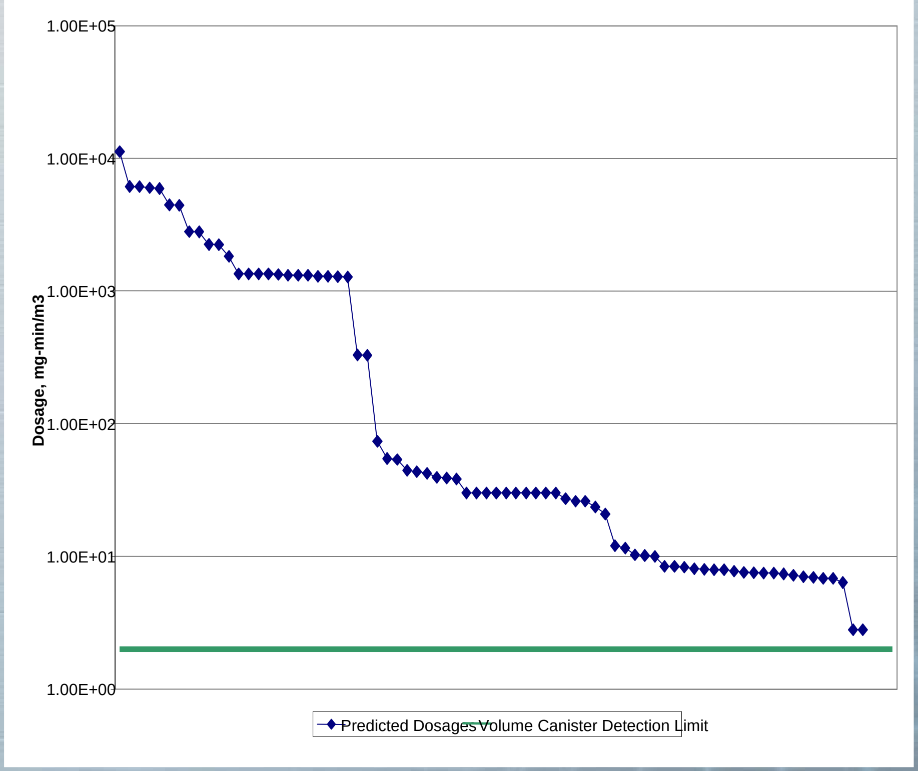
- Selection of sampling locations
  - Release room and adjacent rooms
  - HVAC system returns, supplies and fresh air intakes
  - At primary transport pathways
  - In sets of representative rooms





Test Parameter Selection – Release Mass

- Determination of mass of simulant to be released
  - Release mass chosen to achieve detection but not saturate real-time detectors (release room may be an exception)
  - Release mass chosen to maximize measurable dosages throughout building.



Real-time Detector Location	Max Release Mass to Saturate Detector, g	Min Release Mass to Achieve Detection, g
Release Room	3	0.01
Room 2	85	0.21
Room 3	66	0.17
Room 4	64	0.16

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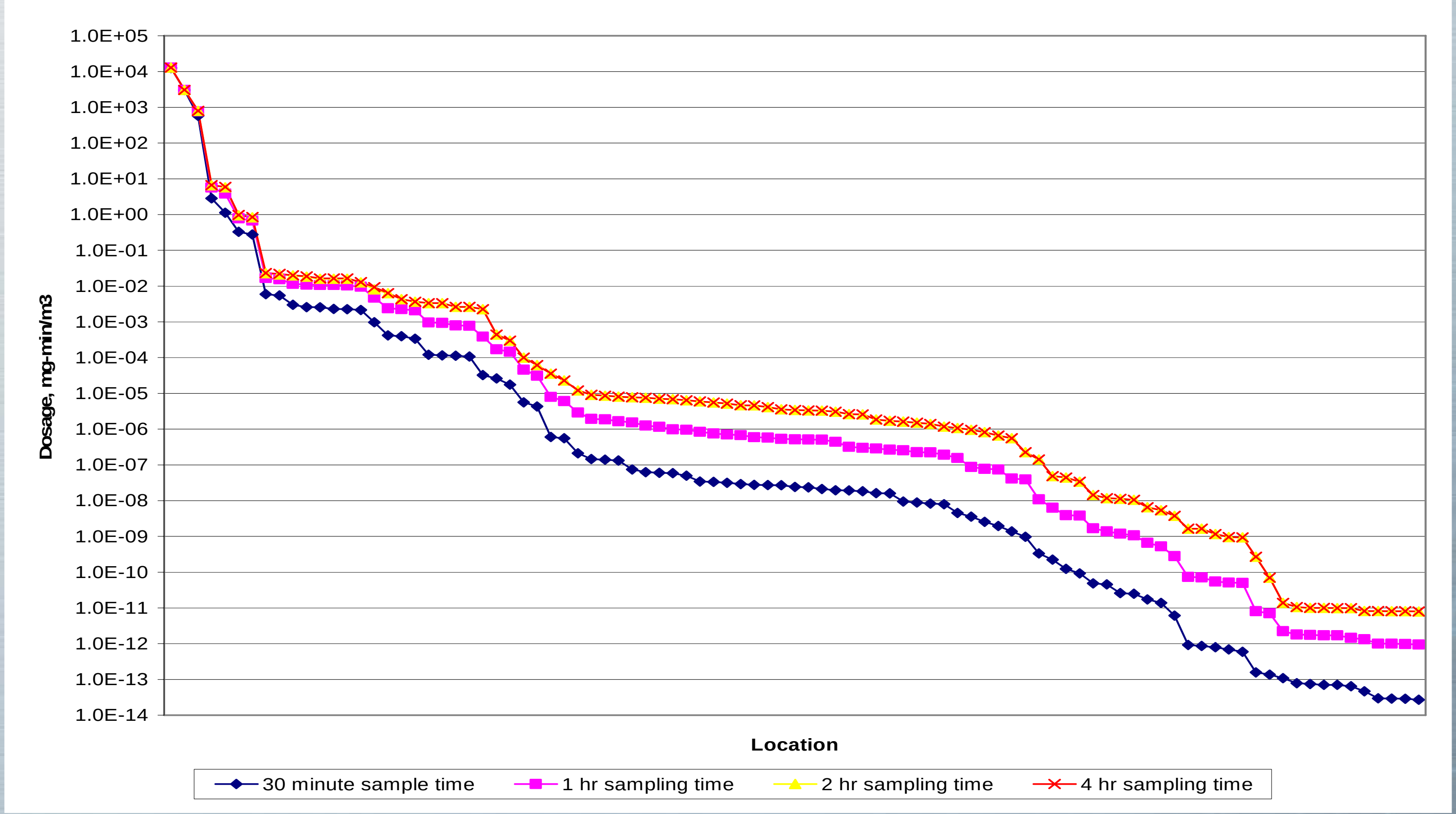
Test Parameter Selection – Sampling Time

- Determination of sampling time
  - Duration of experiment set so that additional sampling time will not significantly affect measured dosages



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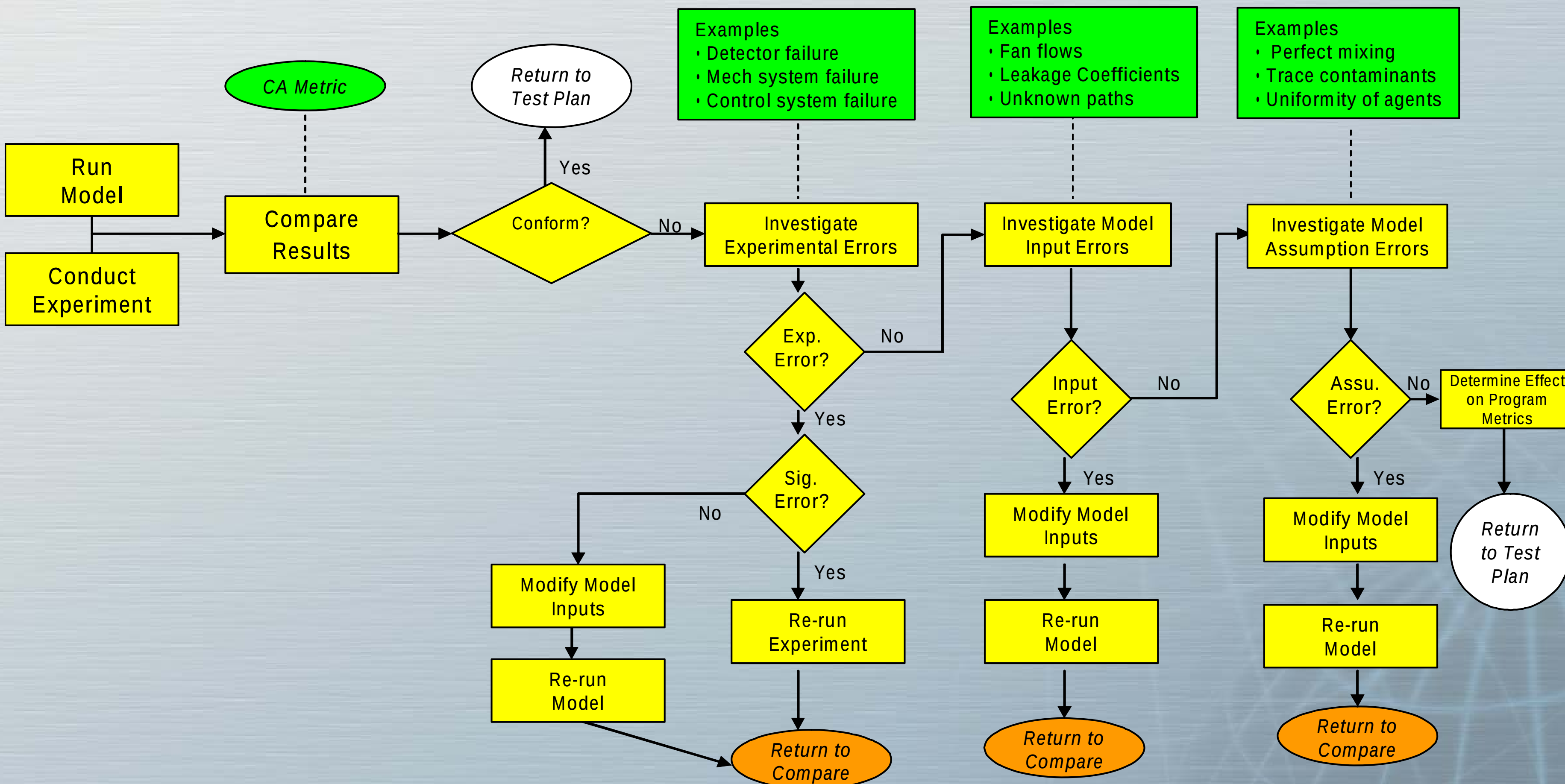
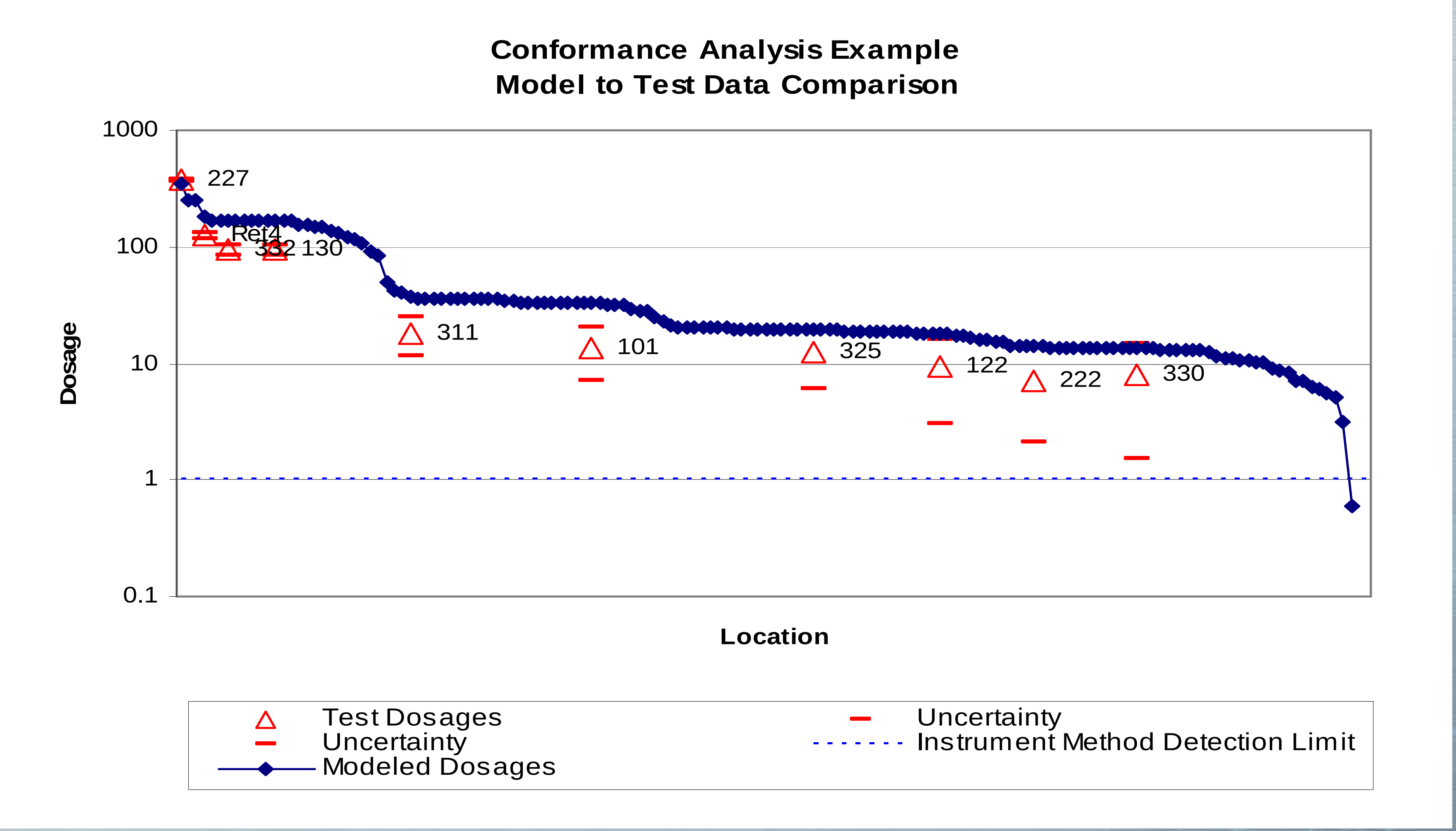
Modeling & Experimentation Conformance Analysis Process

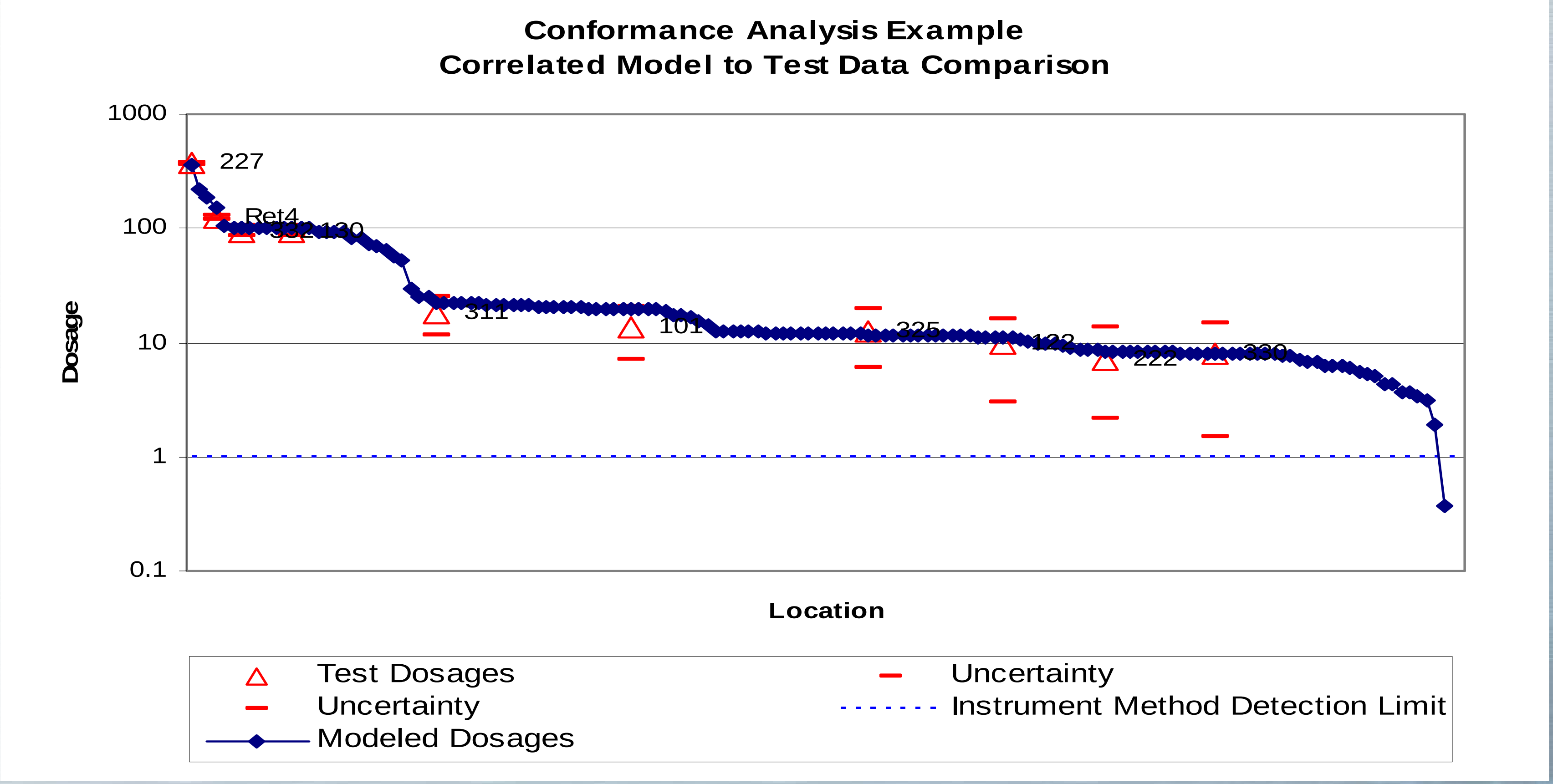


Modeling & Experimentation Conformance



•Comparison of data shows deviations between model and test data

Modeling & Experimentation Conformance



- Fresh air flow-rate model adjustment brings model into better agreement with experimental data.
- Subsequent analysis of all experiments in set indicate adjustment improves or maintains conformance.

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Conclusions and Lessons Learned

- Integration of modeling and experimentation efforts is necessary to deal with the shortcomings of each.
  - Instantaneous, well-mixed assumption of nodal models
  - High cost of experimentation
- Using modeling to support planning of experiments improves efficiency in conduct of experiments.
- Conformance analysis provides an effective means of comparing modeled data to experimental data and identifying model improvements to enhance fidelity of model predictions.
  - Conformance analysis must be applied to all components and all test cases.

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NDIA's 22nd Annual National Test & Evaluation Conference
March 6-9, 2006
Jacksonville, FL

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Open Technology Development & Testing

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Network-Centric Systems

- Can’t create new systems with old tools/processes
- Current methods of acquisition are good when purchasing static componentry
- Not so good at acquiring systems which need to be modular, networked, dynamic, open to unknowable future concepts of operation.

Fostering/enabling innovation is central to network-centric warfare

*INCREASE TRANSACTION RATES**

- ***"The future is here. It's just not evenly distributed."*** ***- William Gibson***

- ***"If you want to succeed, double your failure rate"*** ***- Thomas Watson, Founder IBM***

-

****** Col. John Boyd***

Problem 1: Current Acquisitions System

- Requirements and acquisitions process takes too long
- Needs in the field aren't being addressed in time to have impact
- Cost estimates for major weapons systems continually increasing
- Systems tend to be used to get-the-job done versus by-the-book

Problem 2: Rapidly Changing Threats

Opponents able to plan around our current and future planned strengths and capabilities

Implications:

Capabilities built to meet a moving target

→Red Queen Scenario, enemy evolving with us (co-evolution)

→Competitive disadvantage

As the need to react to rapidly changing threats increases so must our tactics, to include design & testing processes

Current Design/Testing Methods

DOD acquisition system ill equipped to rapidly respond to rapidly morphing threats, leading to the creation of new entities to bypass existing acquisitions processes:

- ACTD Program
- Rapid Equipping Force
- Task Forces (IED, etc.)

Why is this not the norm?

Large Acquisitions Programs

Requirements/
Design

System

→ The Immaculate Acquisition

Fast and the Furious
UAH Production Acceleration

Oct 04 AOR Needs 8105* / Monthly Production

Jul 04 AOR Needs 5000* / Monthly Production 350

May 04 AOR Needs 4454 / Monthly Production 220

Jan 04 AOR Needs 4149 / Monthly / Production 138

Oct 03 AOR Needs 3279 / Monthly Production 81
First Acceleration Dollars Received

Aug 03 AOR Needs 1407 / Monthly Production 80

y 03 AOR Needs 235 / Monthly Production 15

Deficiencies

- DoD develops and has paid for large amounts of software code that isn't readily accessible or reusable.
- Interoperability issues across the services, commands and systems.
- Services constantly reinventing code
- Increasing complexity of software code
- Development costs outweigh COTS costs (if COTS available)
- Timely delivery of new solutions

How network centric systems are acquired influences behavior

Results:

- Stove-piped systems
- Inoperable systems
- Slow creation of systems, lack of agility
- Less innovation

Basic Premise of Solution

Two areas to change for creating network-centric systems

1. The environment for how systems are acquired, designed, utilized and shared
2. Methodologies for acquisitions

Change Methods

Open Technology Development (OTD) methodologies for hardware and software

DoD has spent huge amounts of money developing software code, which is rarely available for reuse.

- Information technology is the glue
- Open-source proven success in the private sector
- Better systems components are evolved, evaluated and tested through a distributed competitive collaborative network.

OTD Overview

- Transition of publicly available OSS into (and out of) DoD
- Development of DoD enterprise code ‘repository’* for reuse
- Enable collaboration across DoD on technology acquisition and development

*Not centralized

OTD Benefits

- Speed of technology deployment
- Avoid constant rebuilding of technology
- Improve technological collaboration
- Leverage external open source technology investments
- Focus new development in appropriate areas

OTD tools

- Manage the software development lifecycle and enable better documentation of code
- More than just a code repository – community and collaboration tools
- Increased code reliability and reduction of interoperability risks
- Increased awareness about developed code.
- Potential savings though reuse of code
- Breeding ground for new ideas
- Treats code as dynamic and evolving vs. static

Industry Understands the Benefits

- Corporate America is transitioning
- IBM - > $1B Investment in Open Source
- Apple - OSX built on open source
- HP - over 200 Open Source based products
- Microsoft uses open source methods internally
- CSC and BAE - Shifting to OSS Model

OT&E & OTD

- Testing & validation plays a key role in OTD
- Community of interest needed to rapidly test and evaluate new systems and rapidly share test technology
- Dynamic environment needed to match testing needs to IT development
- OT&E is part of a dynamic environment
- Testing of NCW systems must move from static testing to constant dynamic monitoring.

Not just Technology

- Need to focus on fostering the creation of an ecosystem that recognizes (and rewards) risk taking and innovation coupled with open architecture systems.

- Questions?
- For further information contact me for:
- AS&C, Open Technology Design Report
- NUWC report: *Network-Centric Warfare, Total Systems Design & Testing, June 2005.*
- **John Scott, johnmscott@mindspring.com, (240) 401.6574**

Effort initiated by: Sue Payton, Deputy Undersecretary of Defense - Advanced Systems & Concepts

References & Additional Information

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- MITRE Corporation Report: *Use of Free and Open-Source Software (FOSS) in the U.S. Department of Defense*, Version 1.2.04, January 2, 2003, Report # MP 02 W0000101
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- Open Source Software vendors: Collabnet, http://collab.net and SourceForge, http://sourceforge.net
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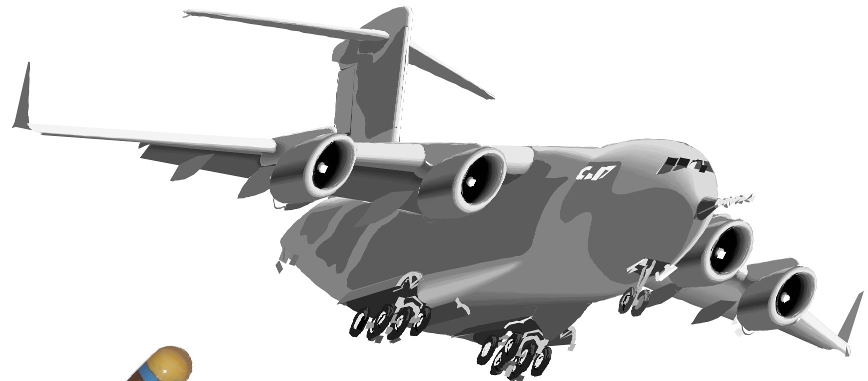
- Raymond, E.S., The Cathedral & the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary, O'Reilly Publishers, 2001
- Open Source Software Institute (deal with Gov issues), www.oss-institute.org
- Open Source and These United States -C. Justin Seiferth, http://skyscraper.fortunecity.com/mondo/841/documents/99-184.html
- Open Source Software for Imagery & Mapping, http://www.ossim.org (great example)

Dual Thrust Modified Smokey Sam for Low Cost Testing and Simulation

NDIA 22nd National Test & Evaluation Conference

9 March 2006



EO Countermeasures Technology Branch
EO Sensor Technology Division
Sensor Directorate
Air Force Research Laboratory

Briefer: Bill Taylor
Tech Advisor for EOCM
AFRL/SNJW

Project Description

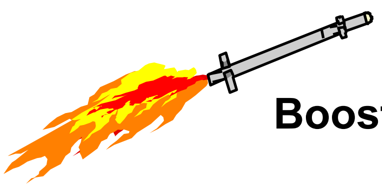
- **Objective(s):**
  - **Develop a low cost, dynamic stimulation capability for EO/IR missile warning and directed IRCM system**
- **Requirements**
  - Provide motions and nominally representative rocket plume signature of MANPADS threats
  - Provide method to stimulate Close Loop Laser IRCM testing
  - Provide method to detect laser emissions from directed IRCM systems
  - Provide controlled trajectory for operations in close quarters, or heavy clutter areas as well as free flight
- **Technical Approach:**
  - Use GTR-18A SMOKEY SAM rocket as baseline capability
  - Naval Surface Warfare Center – Indian Head modifies rocket motor
  - Develop cable launch system for control flight
  - Demonstrate both free & cable launch to validate capability
  - Measures in-band intensities with reference to MANPADS
  - Conduct testing to demonstrate capability

Background

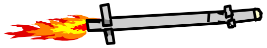
- Smokey Sam is well used rocket for training of aircrews
- Testing using Smokey Sam rockets were useful in functional tests for laboratory programs
- An improved capability was thought to be useful but needed to be low cost for S&T use!

Generic IR SAM Shot Signature

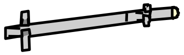
- Baseline missile launch and flyout case:
  - Boost for 1.5 seconds
  - Sustain from 1.5-7.1 seconds
  - Burnout at 7.1 seconds
- Standard atmospheric cases (Desert, Urban, Maritime)
- Signatures at nominal viewing angle
  - Boost: IR=100 W/ster EO=10 mW/ster
  - Sustain: IR=10 W/ster EO=3 mW/ster
  - Burn Out: IR=0.1 W/ster EO=0 mW/ster



Boost

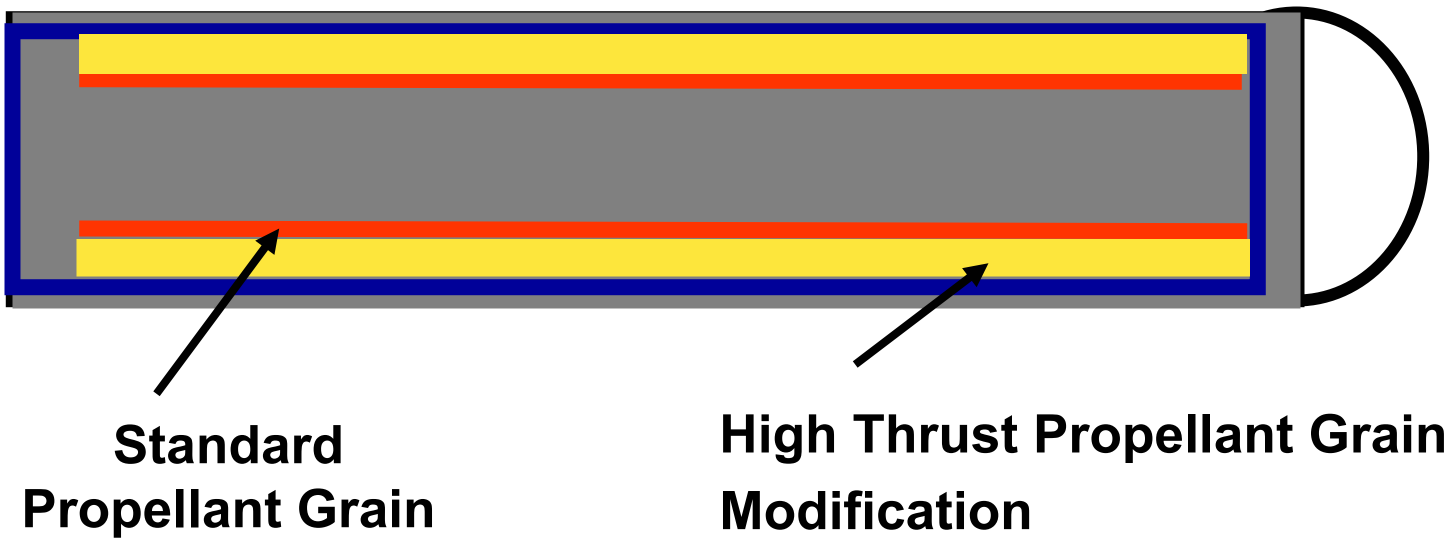


Sustain



Post Burn Out (PBO)

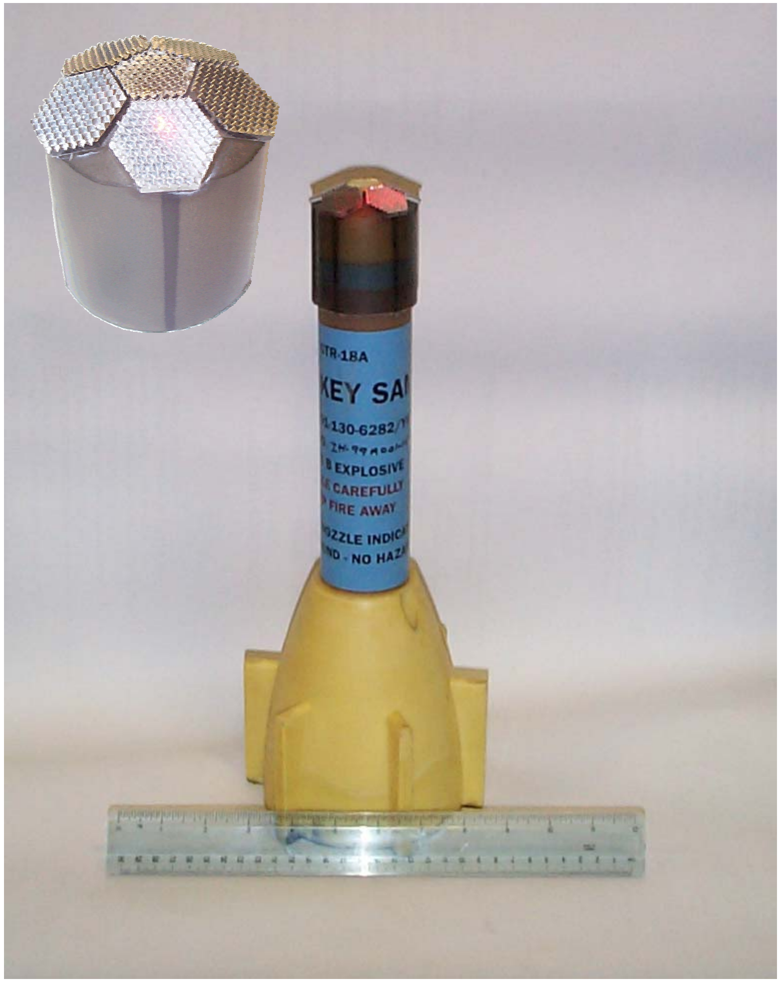
Rocket Motor Modifications



- The GTR-18A Rocket Motor was modified for a two part laminated grain
- External grain is standard zinc based fuel
- Internal grain is Aluminum based grain used in other operational system
- Combination gives a appearance Boost and Sustain signature
- Thrust is low initial but high for majority of burn given improved trajectory

Smokey Sam Test Rocket

• To provide a reflective surface for laser system, a nose cone modification was developed using coated bicycle reflectors



Trailer Launch System

- A telescoping mast trailer was procured and modified to support cable launch operations
- 2000 ft steel .25 in cable is stretched and anchored over the mast

Launcher

- A low cost trolley was develop for the cable system

Trolley

Rocket on trolley
mounted on launcher

Detectors System

- Supporting requirement to detect lasers emissions

Detector and recorder mounted on trolley

Side view of detector/ recorder in trolley

T&E Supported

- Laser Infrared Flyout Experiment
  - 2003 Live Fire Test – WSMR
  - 2004 Live Fire Test – Tonopah
- Affordable Laser IRCM Survivability Program – MWS testing
- Check 6 Testing
  - 2005 Flight Testing – Aberdeen Proving Grounds
  - 2006 Live Fire Testing - WSMR
- Missile Launch Detector Upgrade Testing – WPAFB
- 2005 UK Laser Jammer Test – WPAFB
- 2006 US Laser Jammer Test – WPAFB
- Multiple AFRL MWS testing at WPAFB

Development Process

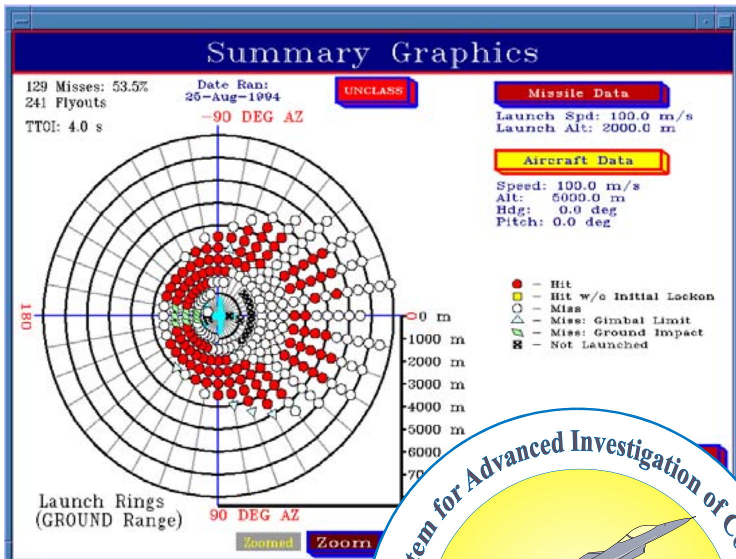
- DT Smokey Sam is a supported element in the overall development process
  - Concept Development
  - Analysis, and simulation studies
  - Build prototype hardware
  - Early testing to confirm design and simulation results
    - Smokey Sam firing provide low cost data
    - May need a few real missile shots to validate
  - Validate design against simulation and empirical data

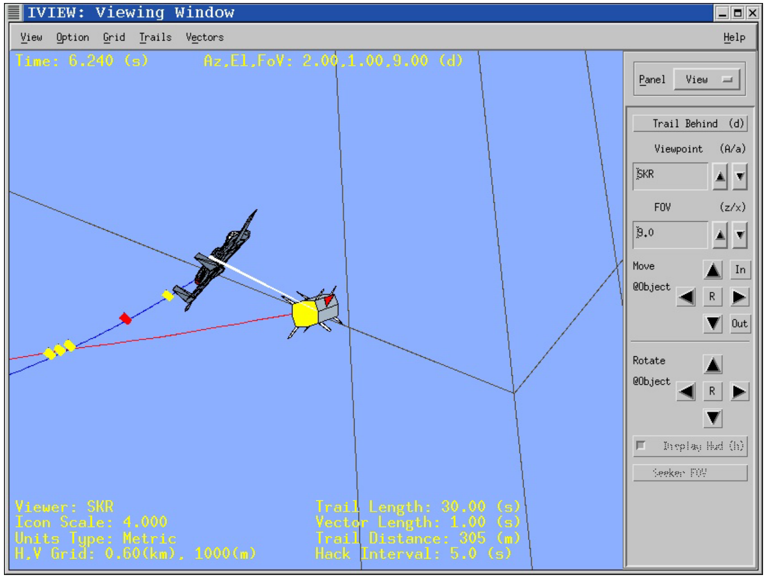
Limitations

- DT Smokey Sam has limitations
  - Dynamics after first few seconds are not representative
  - Closure velocity does not present intensity rise factors used by some MWS algorithms
  - Eject motor signature not represented by rocket launch
    - Working separate eject motor stimulator for MWS testing

Modeling & Simulation Link

- **Emulation level engagement modeling relies on empirical testing for validation**





- **Accurate modeling of missile warning performance and laser IRCM tracking is critical to the design and assessment of countermeasures effectiveness**

Recap

- Dual Pulse Smokey Sam (DTSS) offer a low cost capability for early testing, calibration of optical/infrared missile warning and Directed IRCM systems
- Modification of the widely used GTR-18A Smokey Sam rocket with other innovation provides a useful tool for testing
- As part of concept development, DTSS can be used to validate initial design, analysis and simulations
- DTSS has limitations like all testing tools

CENTER for ASYMMETRIC WARFARE

CAW use of M&S in Support of Maritime HLD/HLS/ATFP Test and Training Exercises

Arman Tchoubineh

NDIA T&E Conference

March 6-9, 2006

OUTLINE

- CAW Background
- Asymmetric Warfare Integration Ctr. (AWIC)
- Why use M&S?
- Types of M&S used by CAW
- Summary and conclusions

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A Gathering Storm?

"We can be certain about trends, but uncertain about events. Adapting to surprise quickly and decisively must therefore be a condition of planning. ***Donald Rumsfeld***

Mission

- **A US Navy agency established in 1999, dedicated to supporting US military forces and local/state/federal organizations in recognizing, countering and controlling the effects of Asymmetric Warfare in support of the Global War on Terrorism**
- **Develop and execute complex scenario-based Exercises involving multiple diverse organizations; expanding on *Maritime/Port Security* environment heritage**
  - **Testing**
  - **Training**
  - **Experimentation**

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Inside the Fence

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Concept

GWOT Mission Areas

- AT/FP
- MIO
- Raid Ops
- NEO
- Strike Ops
- Peace Ops
- DSCA

Testing
Training
Experimentation

Instrumented Infrastructure	Live/Virtual/ Constructive Participants	Complex Scenarios

Integrated GWOT Environment

GWOT Mission Areas

- Intel Ops
- Special Ops
- Nation Assistance
- Freedom of Navigation
- Counter Drug Ops
- Spt to Insurgency
- Recovery Ops

People, Processes, and Infrastructure
RDT&E
Exercise Planning

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Subject Matter Experts
WMD/WME Technologies
Counter-Terrorism

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Products and Services

Training & Exercises

Mission Management & Rehearsal

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Integrated AW Environment

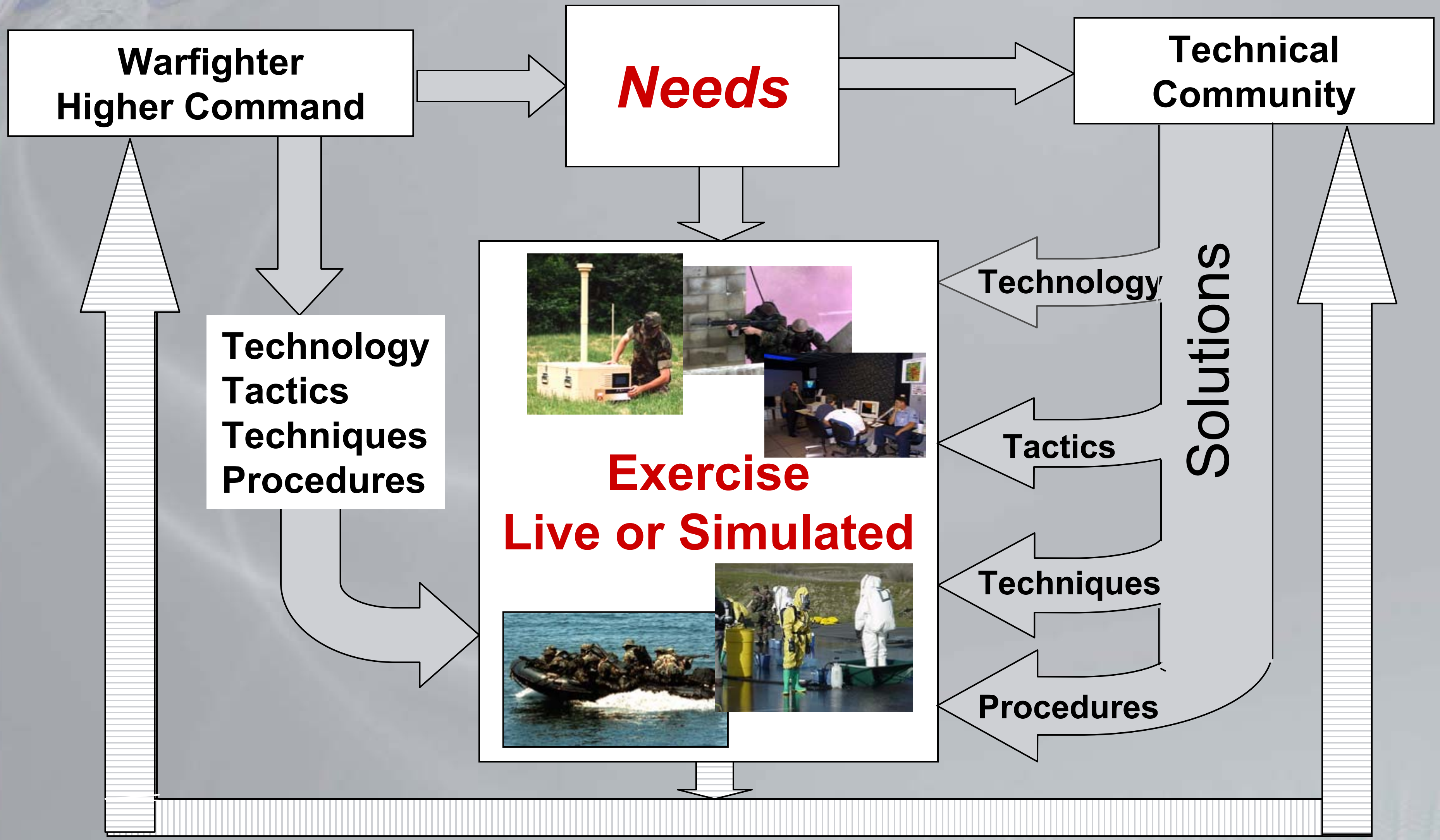
- **Simulation Development**
- **Exercise/Research Support**
- **Scenario Dev & Documentation**
- **Terrain and Org Data Development**
- **Real/Virtual targets/threats**
- **White Cell**
- **Red Cell (OPFOR)**
- **Intel Cell**
- **METOC Cell**
- **Metrics**

Technology Assessment & Analysis

Tactics & Procedures Development

Center for Asymmetric Warfare

Technology Insertion



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Asymmetric Warfare Integrated Center (AWIC) Integration

DOD

Academia

War Fighter

Industry

SIPRNET

DREN/DNET

GCCS-M

JWICS

INTEL Community

Civil Sector

Private Sector

CAW Exercise Control Center

<u>Tools</u>

- METOC
- GioVIZ, Keyhole
- E-TEAM/NC4
- DIMAS
- JCATS
- VTC

RDT&E, Training, Systems Integration, Joint Operations

Asymmetric Warfare Integration Center (AWIC) Capabilities

- **Capable of distributing and recording data (Integrated, Net-centric)**
- **Live and simulated data feed**
- **Multi-Level classified/unclassified data**
- **Provide access to various facilities/agencies**
- **Links to mobile data collection capabilities**
  - Sensors from the CAW floating vessel or van
- **Utilized as an Exercise Control Center (ECC)**
- **Utilized as a training and communication center**

CENTER for ASYMMETRIC WARFARE

Why CAW Uses M&S?

Two aspects of the interoperability exercise lend themselves to simulation: response activities by the participating agencies and Red operations (or natural events).

M&S is used in our events where:

- **Impact of live play would be prohibitive**
  - Obstruction of/Destruction to infrastructure, Health hazards
- **There are insufficient resources**
- **There is insufficient time**
- **A variety of scenarios and their impacts can be demonstrated**
  - In an exercise or In a Table Top discussion

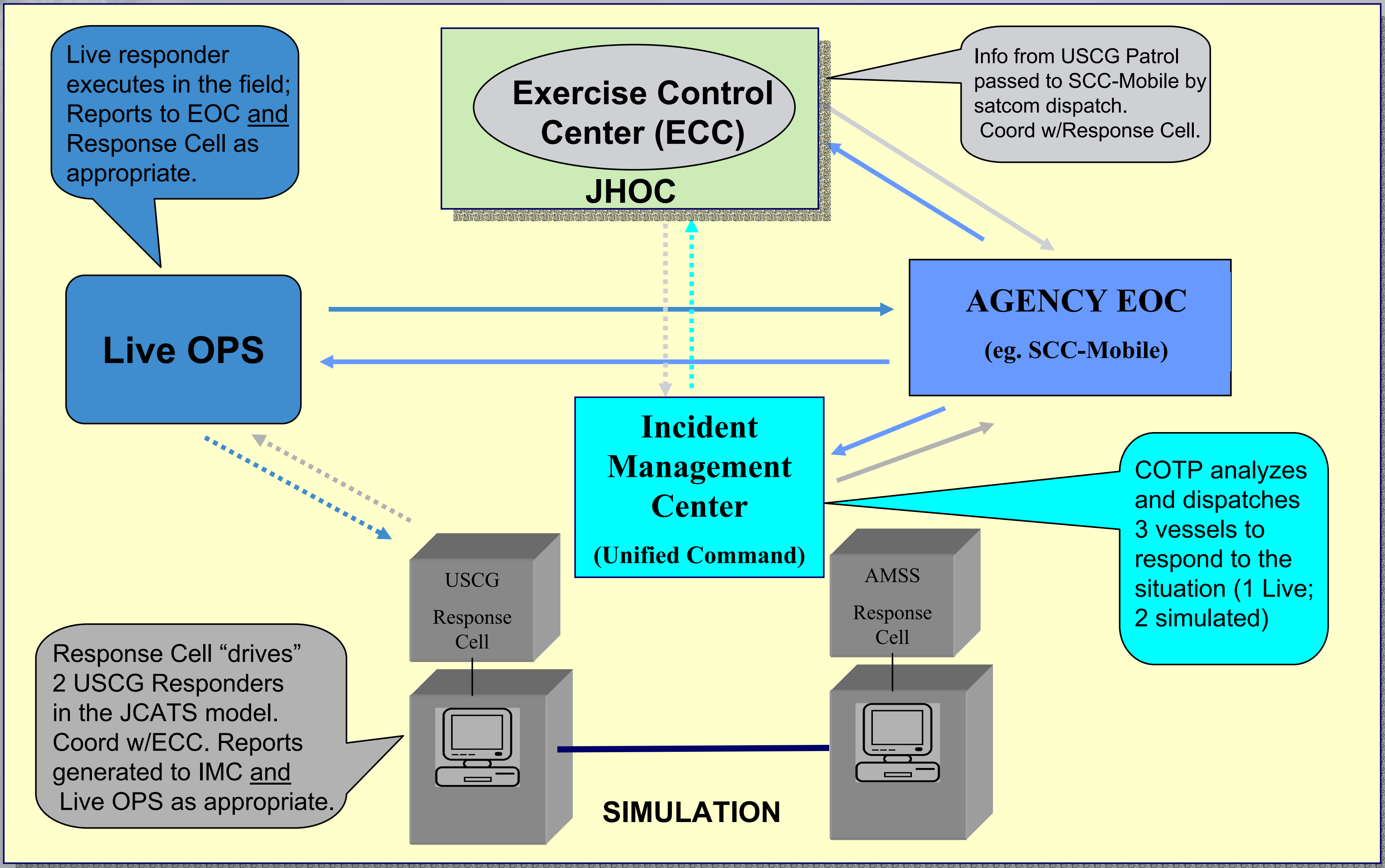
CENTER for ASYMMETRIC WARFARE

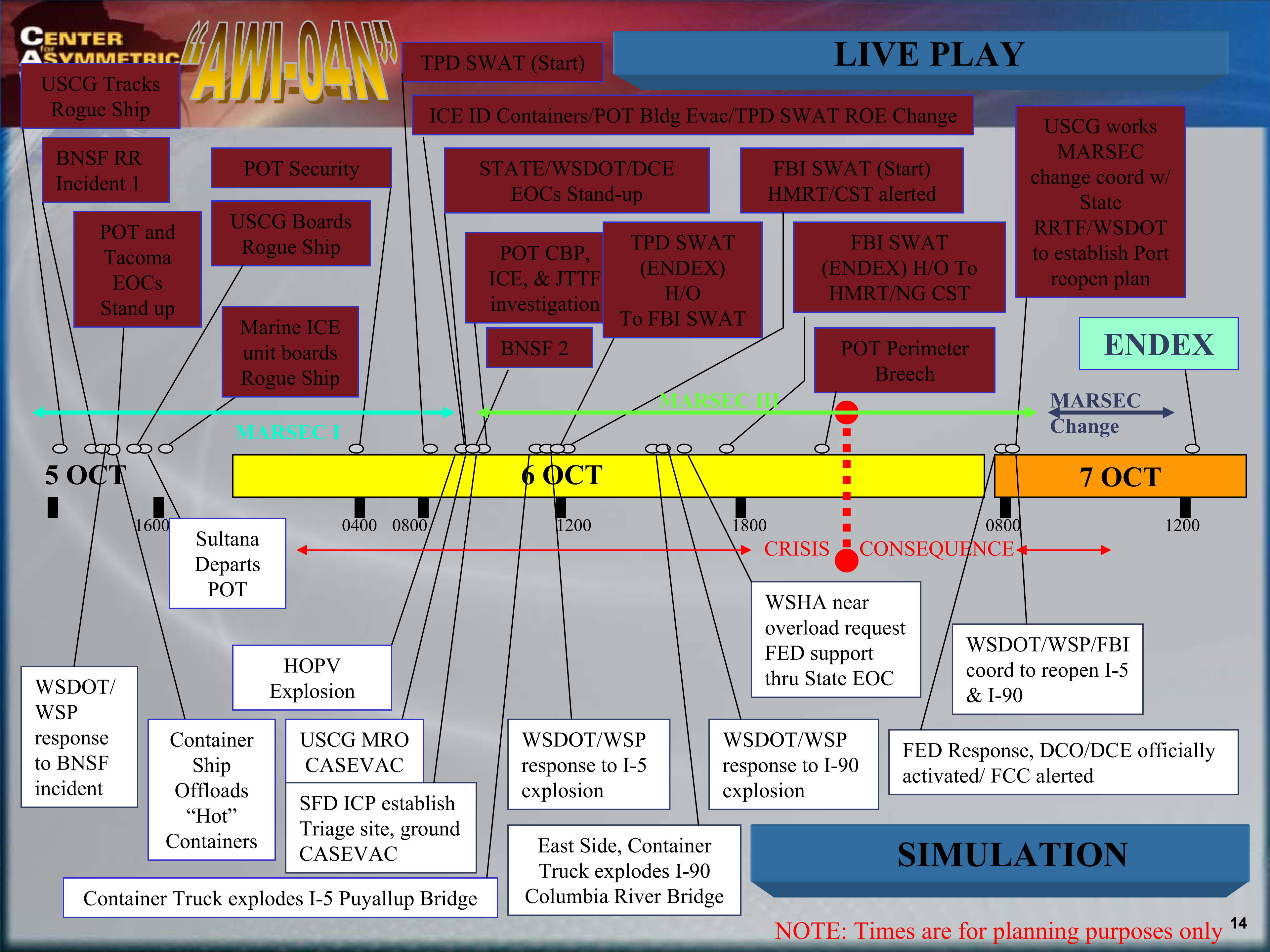
Simulation Characteristics/Benefits

- **High Level Scripting**
  - Loosely scripted actions provide ground truth representation that can also be recorded/played back
  - Calculated response to commanded activities
  - Easily controlled ad hoc injects
  - Detailed element and terrain data required

- Scenario development and run time costs are minor therefore it reduces exercise and training costs.
- Scenario plays out logically, with unrestricted interactive play.
- Terrain and entity data detail is readily available.

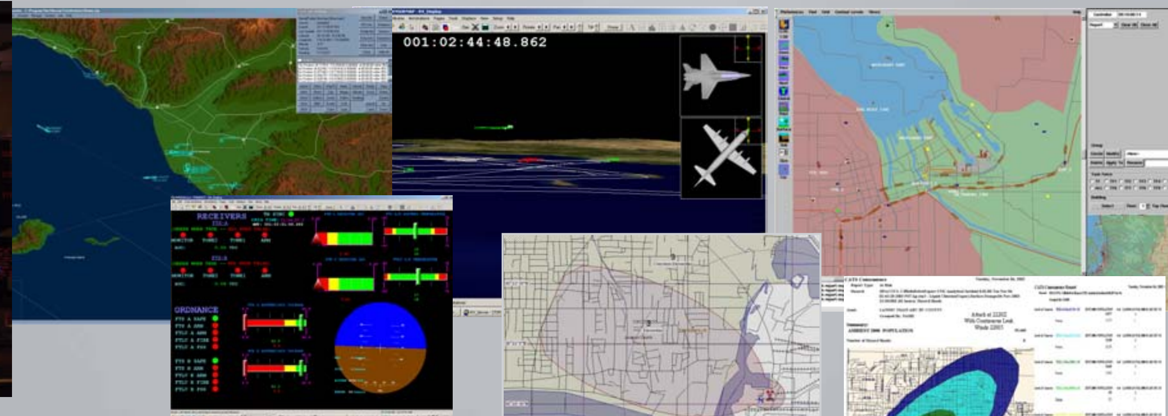
Info Activity Flow

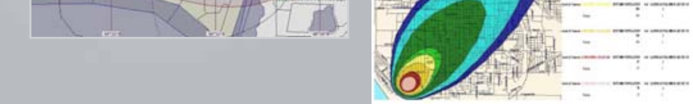




CENTER for ASYMMETRIC
"AWI-04N"
LIVE PLAY
USCG Tracks Rogue Ship
BNSF RR Incident 1
POT and Tacoma EOCs Stand up
POT Security
USCG Boards Rogue Ship
Marine ICE unit boards Rogue Ship
TPD SWAT (Start)
ICE ID Containers/POT Bldg Evac/TPD SWAT ROE Change
STATE/WSDOT/DCE EOCs Stand-up
POT CBP, ICE, & JTTF investigation
TPD SWAT (ENDEX) H/O To FBI SWAT
BNSF 2
FBI SWAT (Start) HMRT/CST alerted
FBI SWAT (ENDEX) H/O To HMRT/NG CST
POT Perimeter Breech
USCG works MARSEC change coord w/ State RRTF/WSDOT to establish Port reopen plan
ENDEX
MARSEC I
MARSEC III
MARSEC Change
5 OCT
6 OCT
7 OCT
1600
0400
0800
1200
1800
0800
1200
CRISIS
CONSEQUENCE
Sultana Departs POT
HOPV Explosion
WSDOT/ WSP response to BNSF incident
Container Ship Offloads "Hot" Containers
USCG MRO CASEVAC
SFD ICP establish Triage site, ground CASEVAC
Container Truck explodes I-5 Puyallup Bridge
WSDOT/WSP response to I-5 explosion
East Side, Container Truck explodes I-90 Columbia River Bridge
WSDOT/WSP response to I-90 explosion
WSHA near overload request FED support thru State EOC
WSDOT/WSP/FBI coord to reopen I-5 & I-90
FED Response, DCO/DCE officially activated/ FCC alerted
SIMULATION
NOTE: Times are for planning purposes only

CAW Modeling and Simulation





- **JCATS:** Joint Conflict and Tactical Simulation
- **GeoViz/Keyhole**: Geo-spatial representation/locator
- **Tier:** Simulation tool to provide situational awareness
- **RangeView:** M&S tool provides Common Operating Picture
- **Air Transport and Dispersion (Plume) Modeling**:
  - **HPAC:** Hazardous Prediction and Assessment Capability (DTRA)
  - **VLSTRACK:** Vapor, Liquid and Solid Tracking (USN)
  - **CAMEO/ALOHA:** Areal Locations of Hazardous Atmospheres (NOAA & EPA)
  - **CATS/JACE:** Consequences Assessment Tool Set, Joint Assessment of Catastrophic Events (DTRA, FEMA & NGIC)

Center for Asymmetric Warfare

Decision Parameters

- **Live play requirements:**
  - If all response play is live, computer sim advantage is minimal.
  - If live play is not essential, computer sim can reduce logistics and costs
- **Scope and complexity**
  - As scope increases, computer sim becomes more effective, especially if events are strongly linked.
  - Complex events are easily managed within computer sim
- **Preparation Costs**
  - Late changes easily accommodated in computer sim.
  - Consider computer sim support staff availability/cost & prep time.
- **Level of play**
  - Increase in level causes exponential increase in C2 and response elements
- **Participant availability**
  - Computer sim flexibility for filling in participant gaps.
- **Classified ops**
  - Performed w/ relative ease on a secured computer.

Summary

CAW is providing training, technology testing and evaluation, and the foundation for developing Tactics, Techniques, and Procedures (TTP) for controlling and neutralizing the effects of Asymmetric Warfare in complex scenario-based series of live/virtual/constructive exercises.

Use of simulation has improved capabilities and situational awareness at a reduced cost.

Conclusion

- Using sims in conjunction with live play or Table Top exercises can improve effectiveness and efficiency and reduce costs (depending on the participant's interests)
- The live and sim techniques can be combined to make best use of attributes from each.
- Together, they can provide improved situational awareness for the participants.

Questions?

Visit us at our website:

www.ctrasymwarfare.org

Modeling and Simulation to Advance Test and Evaluation

Presented to 22nd Annual National Test and Evaluation Conference

March 6-9, 2006
Jacksonville, FL

Stephen Attaway
Sheldon Tieszen

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Sandia National Laboratories

Acknowledgments

- Authors are privileged to give an overview of the work of many individuals
  - Test and Evaluation
    - Experimental infrastructure support
    - Conduct of experiments
  - Modeling and Simulation
    - Numerical infrastructure support
    - Conduct of simulations

Presentation Outline

- Two examples showing M&S and T&E synergy will be given
  - Structural example – Steve Attaway
  - Thermal example – Sheldon Tieszen
- General comments will be given on the cost of a combined approach.

Synergy

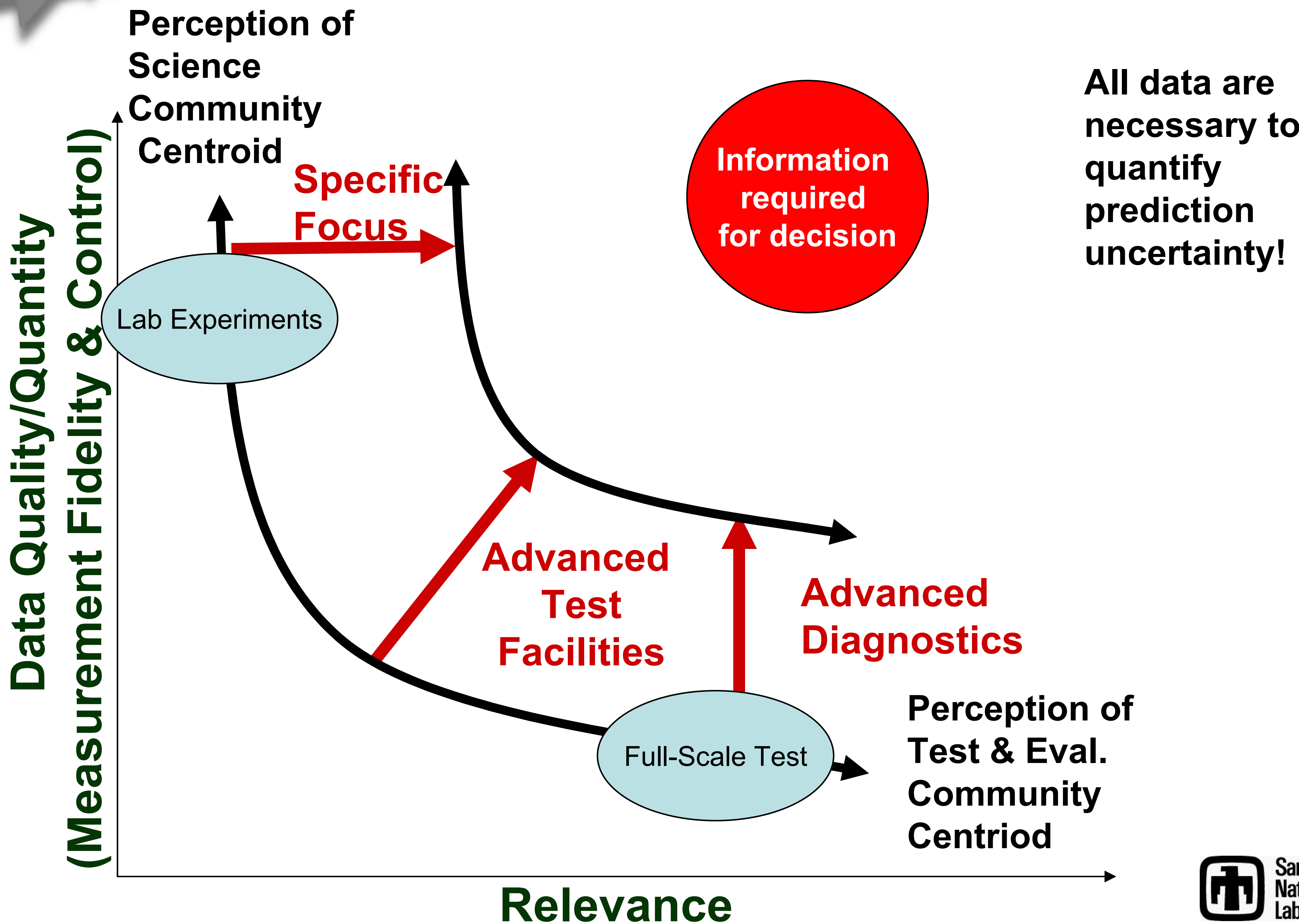
- Both M&S and T&E have strengths, both have weaknesses
  - Experiment: The full truth partially exposed
    - If you cannot measure the key phenomena, no amount of testing will give you the understanding of margin
    - Some things are too costly to test with existing technology
  - Simulation: The partial truth fully exposed
    - If your model does not contain the key phenomena, no amount of simulation will give you the understanding of margin
    - Some things are too costly to model with existing technology
- Combination of M&S and T&E is stronger than individual components
  - Information content (T&E strength, M&S weakness)
  - Information diagnostics (T&E weakness, M&S strength)

Goal and Approach

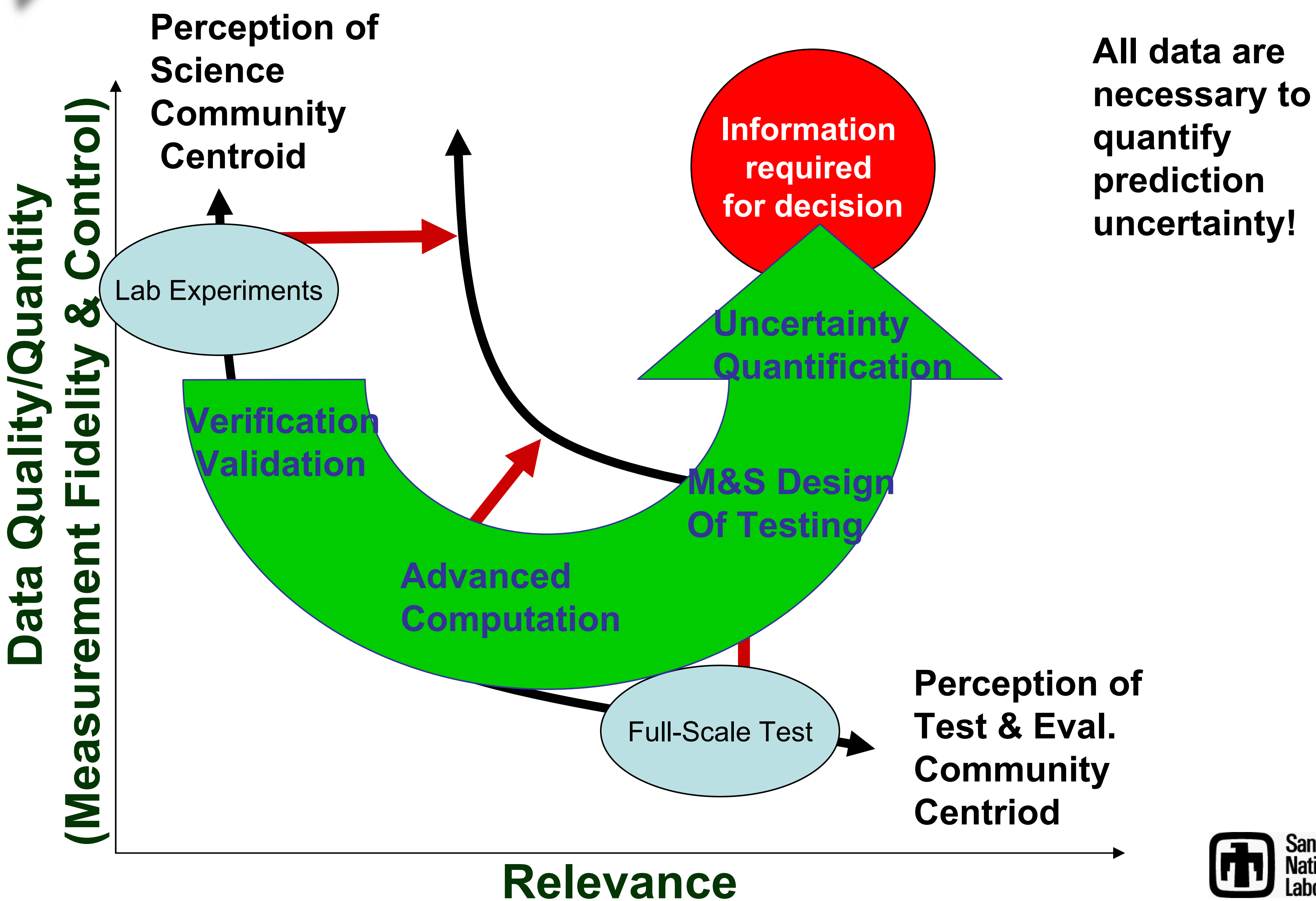
- Our goal is to
  - Provide the technical basis for high-consequence decisions relative to system safety and performance margins

- Our approach is to
  - Combine *Modeling and Simulation* with *Test and Evaluation*
  - Use a Verification, Validation & Accreditation framework to establish that our physical understanding is sufficient
  - Make risk-informed decisions with respect to system safety or performance failure margins

Test and Evaluation is Science in Relevant Conditions

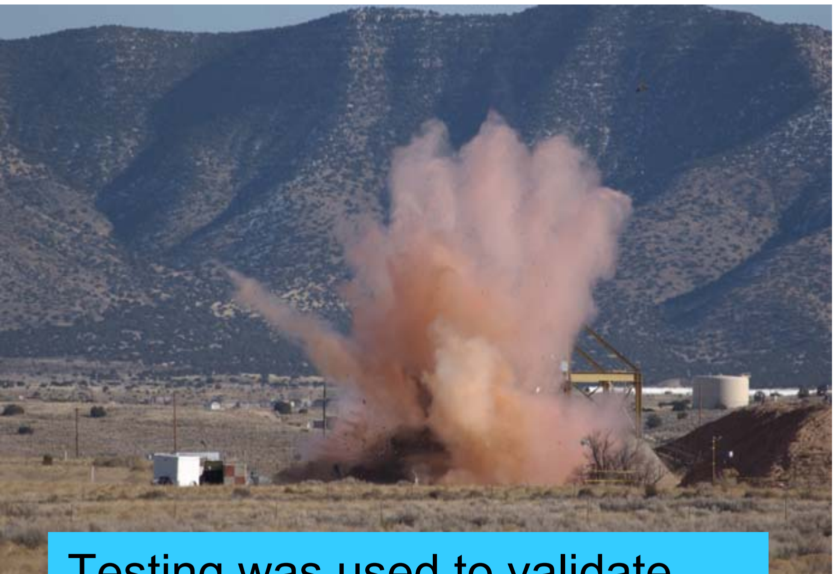


M&S Advances T&E to Decision Goal



Sandia National Laboratories

Example #1
Validation Test of Concrete Simulations



Testing was used to validate our ability to simulate heavy damage to reinforced concrete

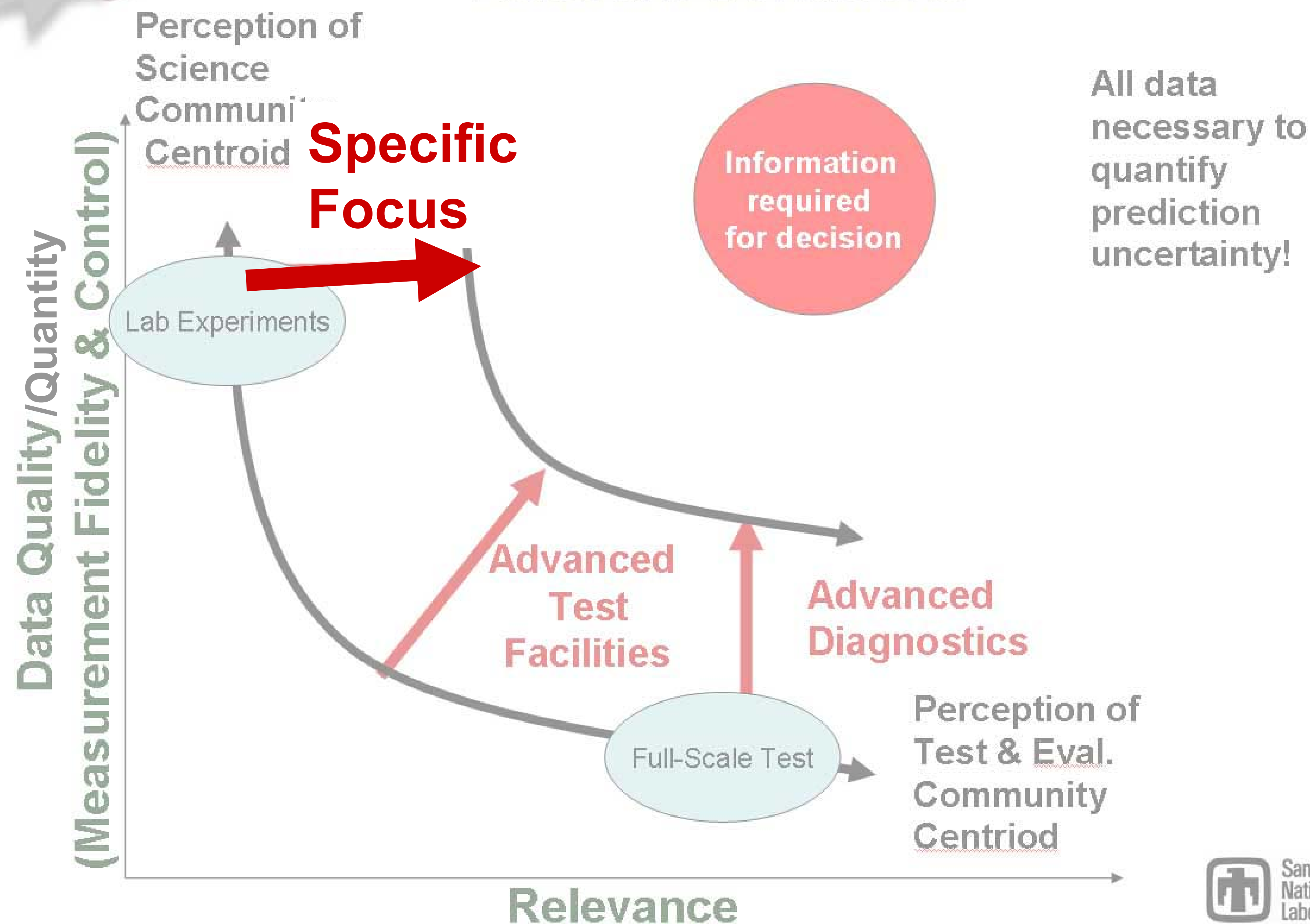
How does this test/analysis combination improve the prediction of behavior for defense and homeland security systems?

- Validated computational tools for modeling collapse of concrete
- Knowledge gained from modeling reinforced concrete will benefit many programs
- Provides more accurate input to risk based decisions

Critical to understanding concrete behavior and quantifying design margins

Sandia National Laboratories

Test and Evaluation is Science in Relevant Conditions



Test goals

Capture the response of a reinforced concrete structure in the process of collapse.

Quantify the load deflection curve defined in Uniform Facility Criteria (UFC 3-340-01)

Quantify how the membrane response contributes to the energy absorbing ability of the structure

Measure the deflections of the wall as a function of load

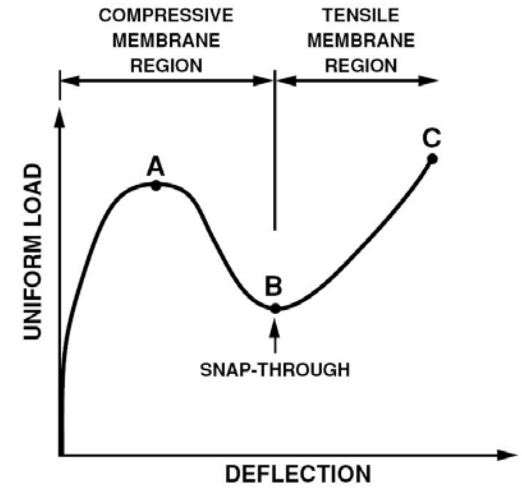


Figure 10-7. Typical Membrane-Enhanced Flexural Resistance Function.

10-18

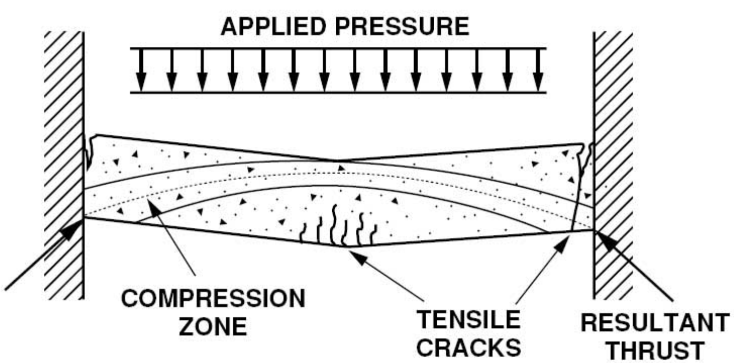


Figure 10-9. Compressive Membrane Action.

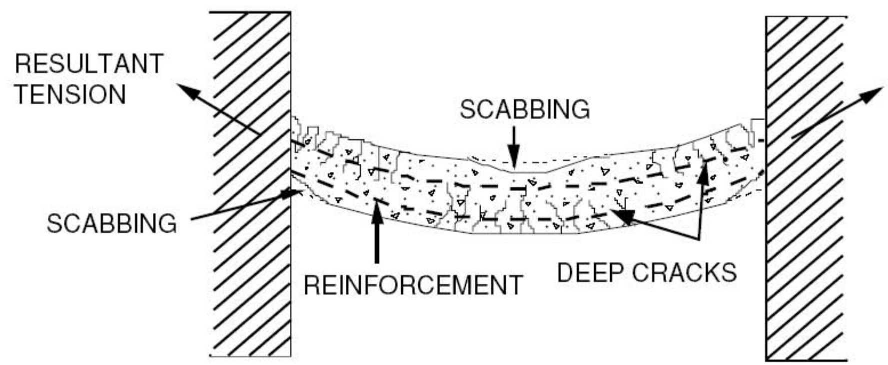


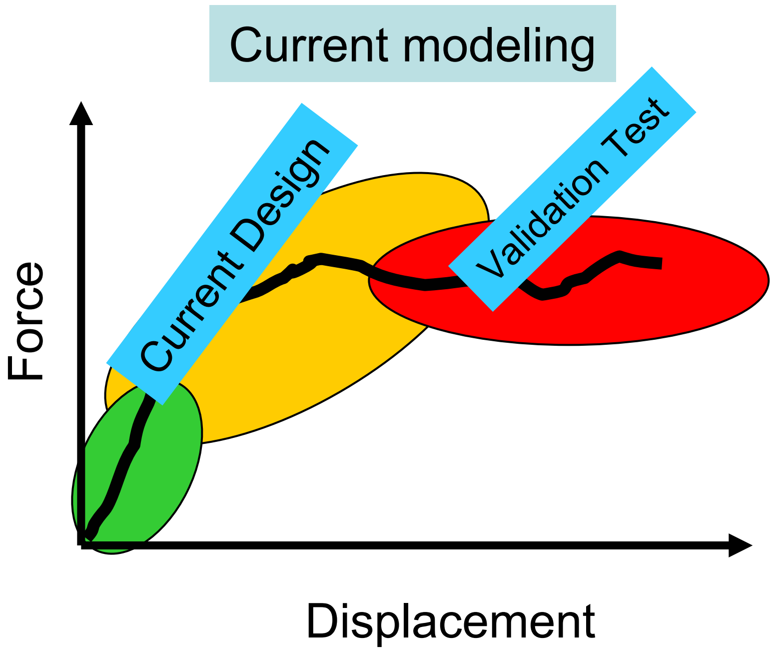
Figure 10-12. Tensile Membrane Action

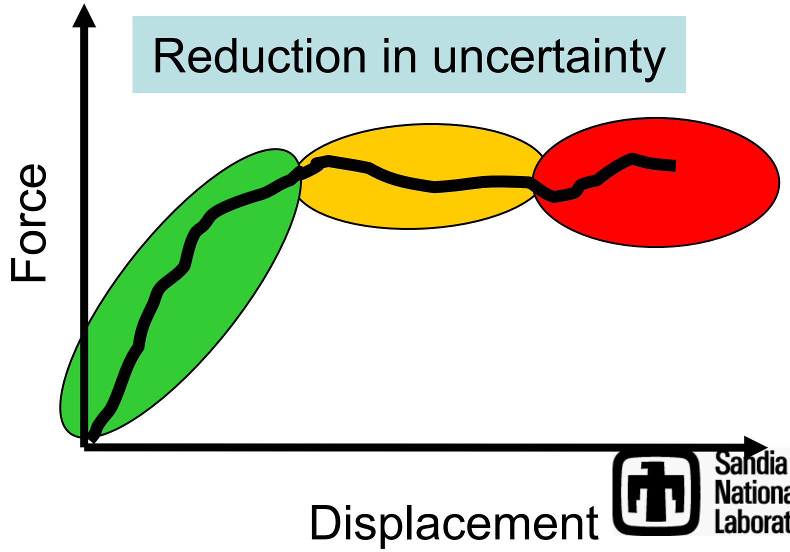
Uncertainty Quantification

Large uncertainty may result in facilities being over designed

Reduction in uncertainty equals reduction in cost

- Validation test was designed to produce a response in in the yellow/red zone
- Current design point is in the green/yellow zone.





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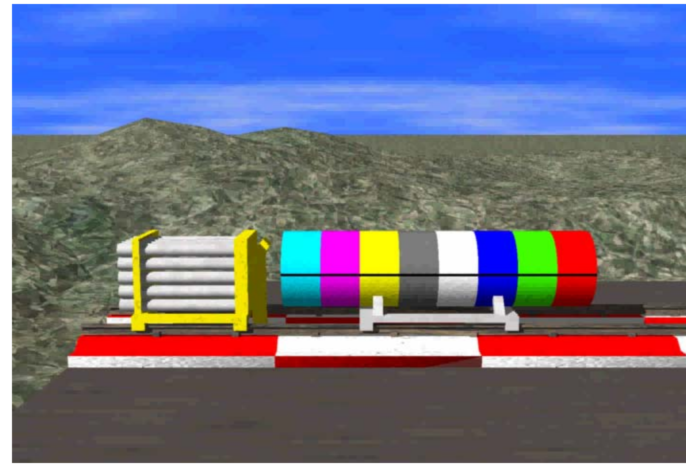
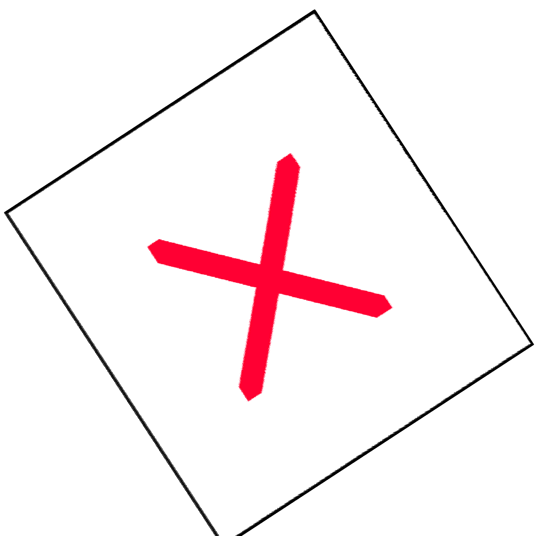
Surrogate Load

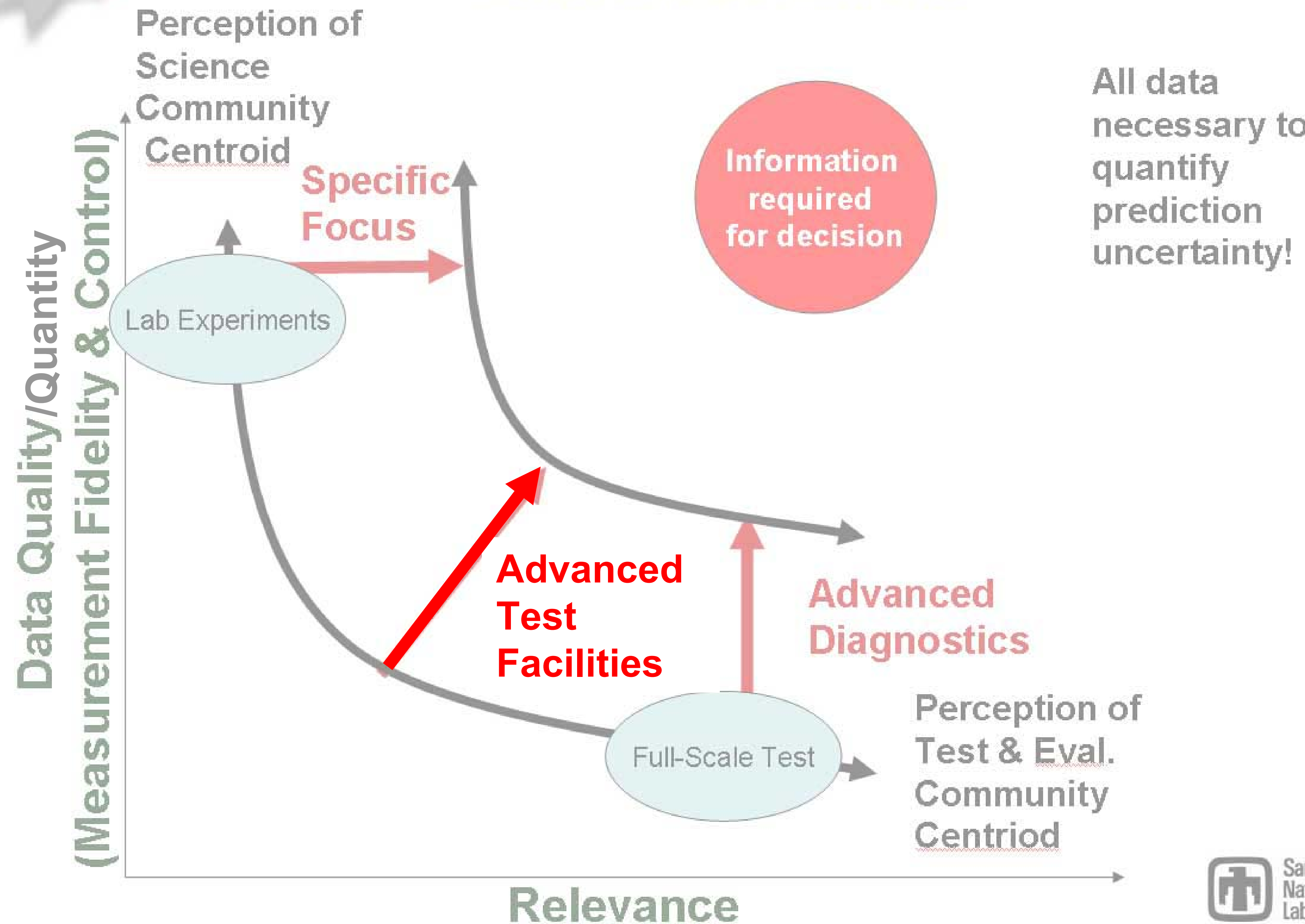
A water slug was used to drive the structure response

Water was slug accelerated to 600.1 ft/sec on high speed sled track using 48 rocket motors





Test and Evaluation is Science in Relevant Conditions



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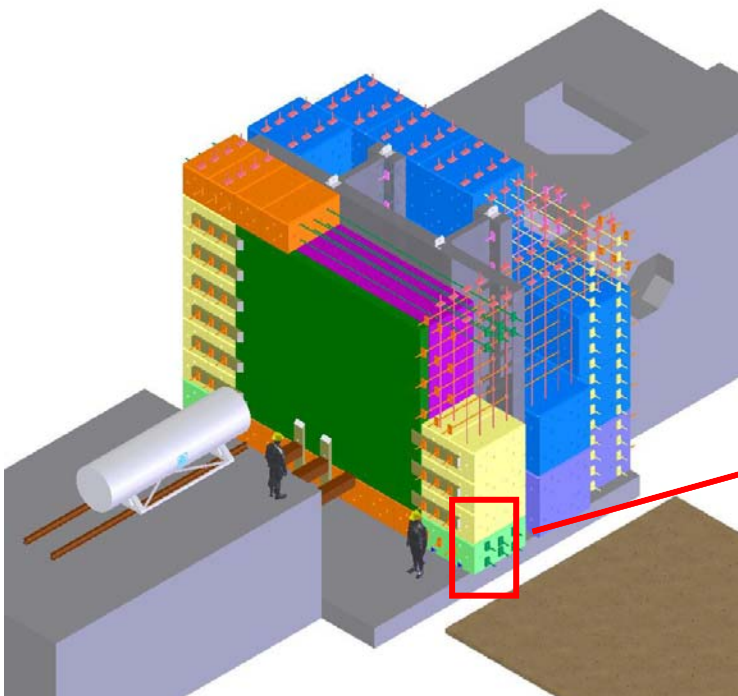
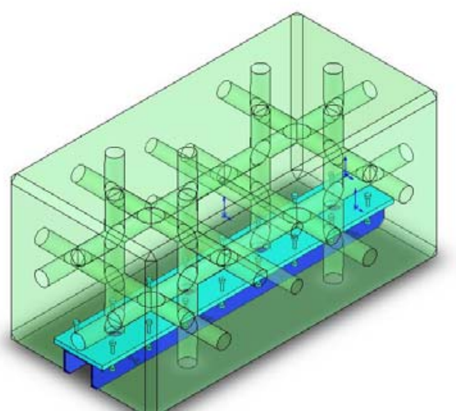
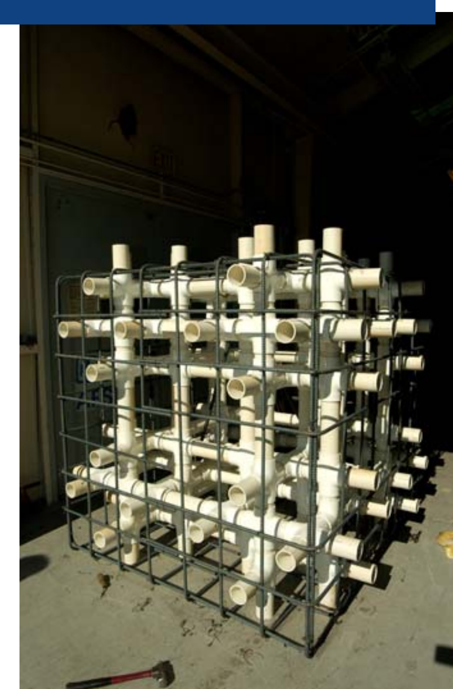
Agile Reaction Frame

- Re-usable post-tension reaction frame used to confine soil, support slab, and support wall section







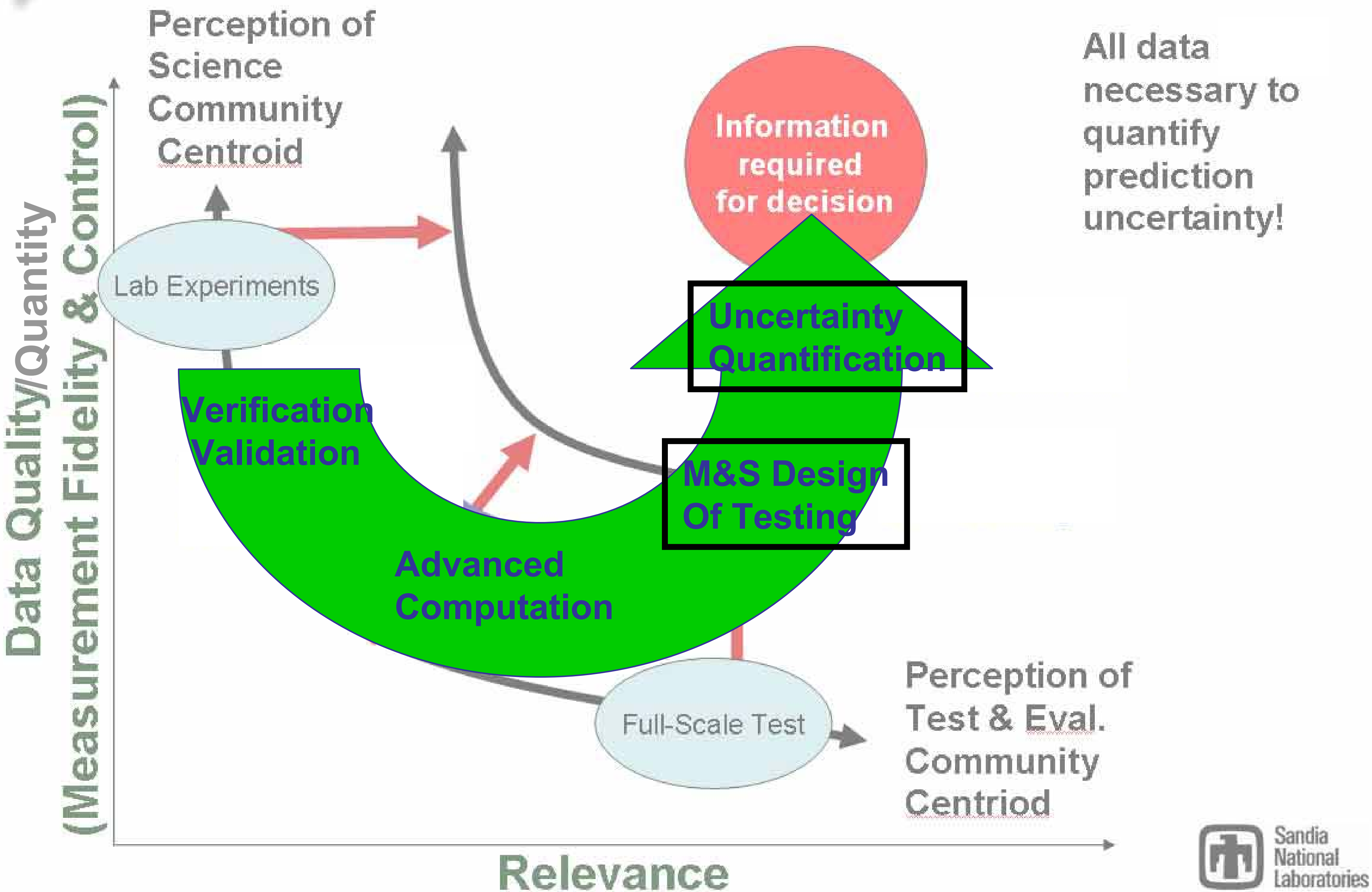


3-5


4N52V


Time lapse video

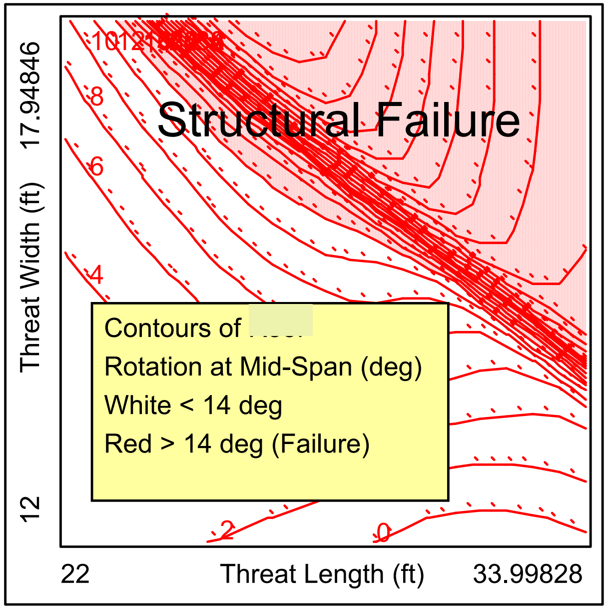
M&S Advances T&E to Decision Goal



Test Design Parameters

- Test parameters were based on statistics-based multi-dimensional sampling
  - Thousands of 2D simulations were used to define a failure surface
  - 3D high fidelity simulations were used to define specific test parameters

- Design parameters:
  - Load magnitude
  - Soil cover
  - Soil strength
  - Structure Span
  - Concrete strength

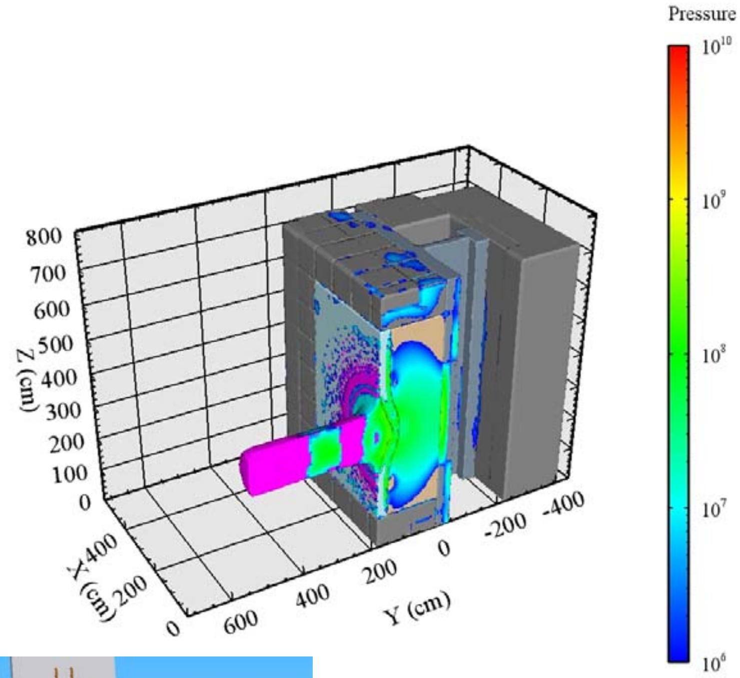


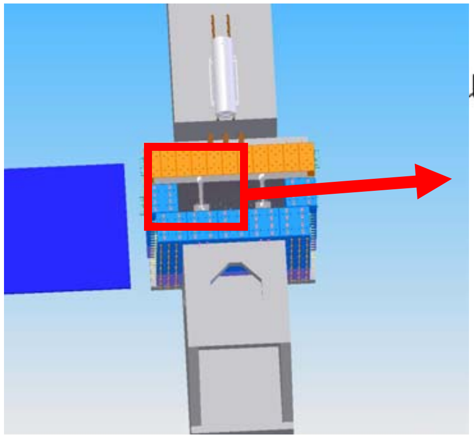
3D Pre-Test Prediction

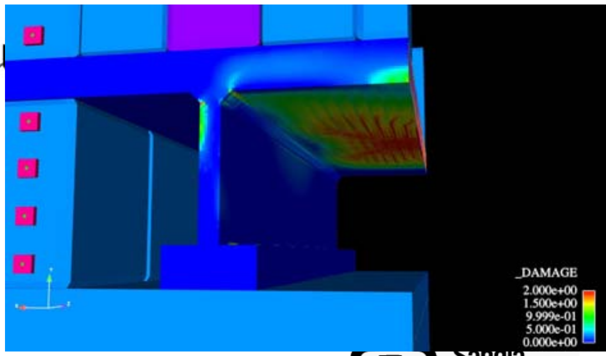
Eulerian model of water slug, soil, and target structure

One-way coupling between Eulerian model and FEM model

FEM model included explicit treatment of reinforcing steel, post tensioning, gravity pre-load and contact between blocks.







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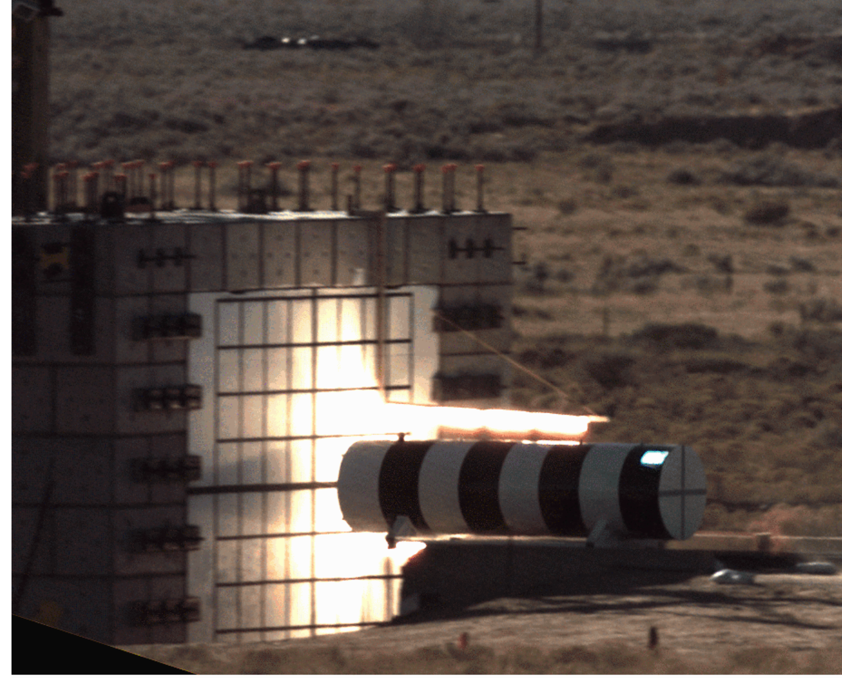
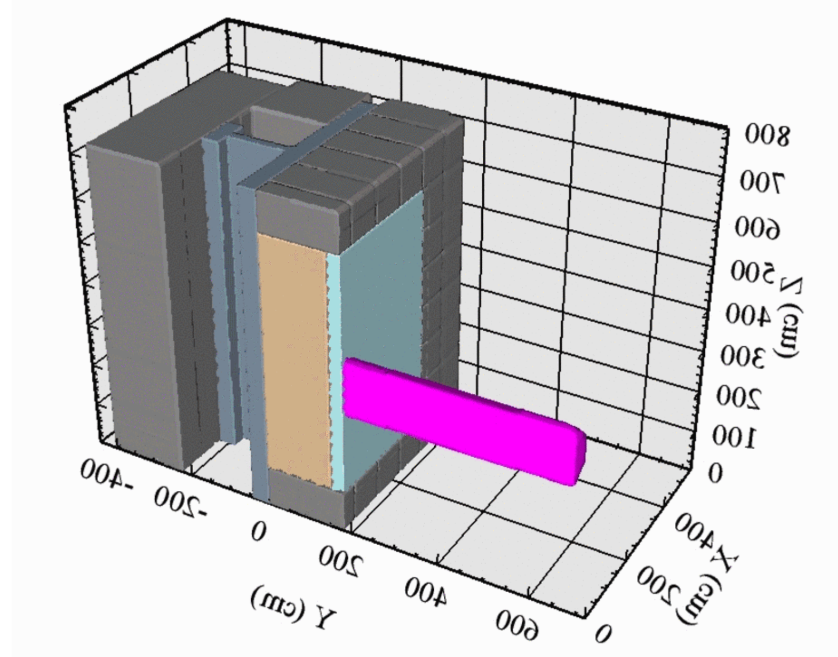
Test Results

- 100% success on instrumentation
- Pressures measured at soil/concrete interface
- Three independent displacement measurements
- Excellent high speed video
- New “speckle correlation” displacement measurement technique provided full-field displacements and velocities for back wall surface





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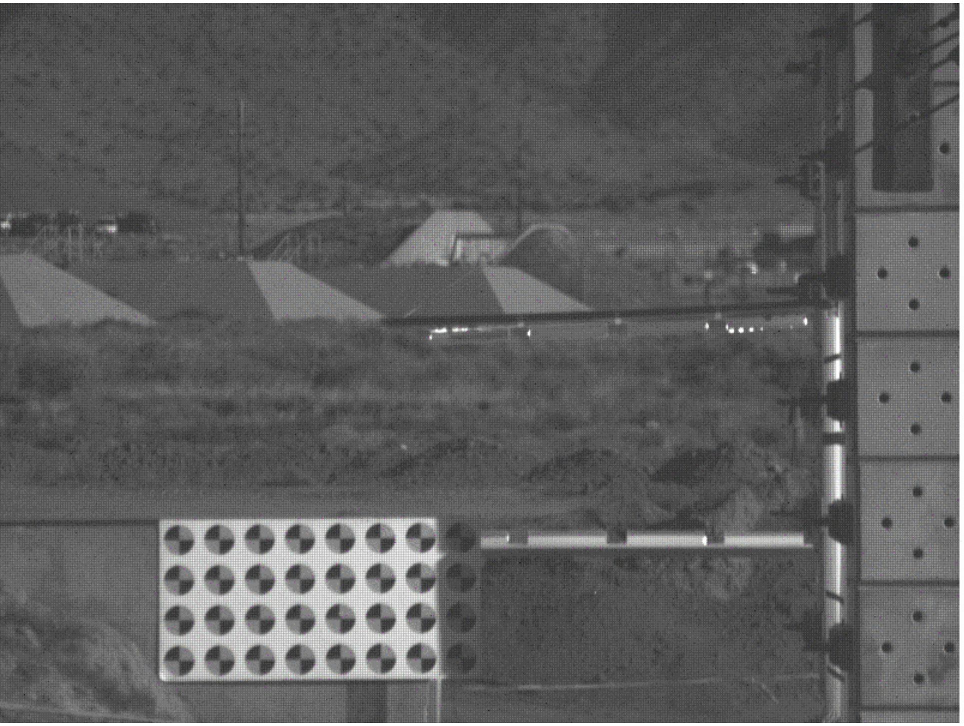
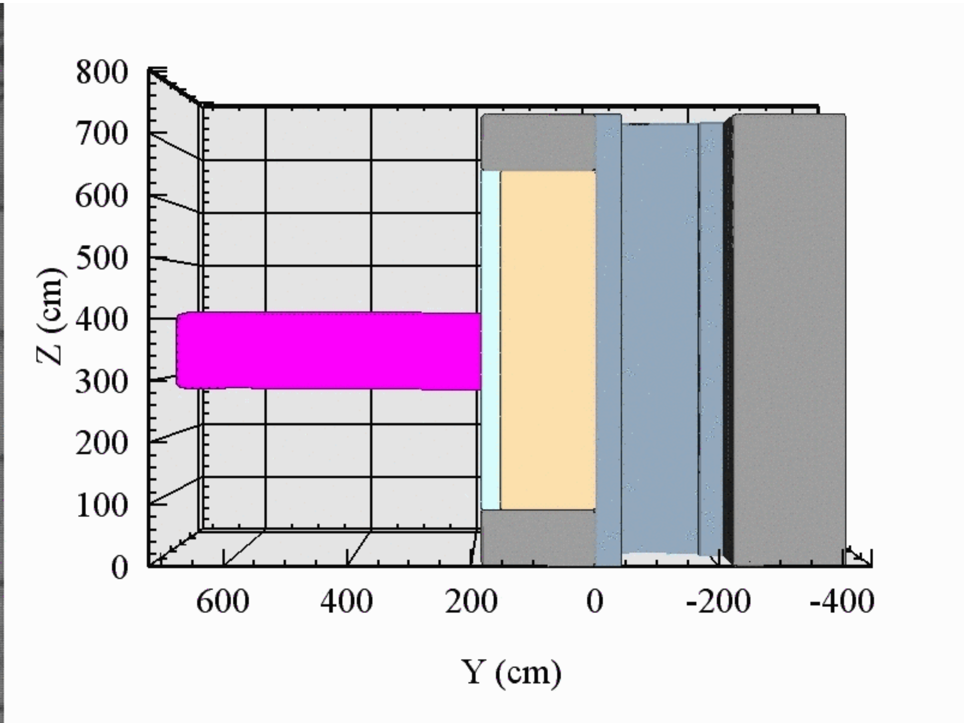
Side view of impact





CTH simulation

4x16 ft water slug moving
at 600 ft/sec

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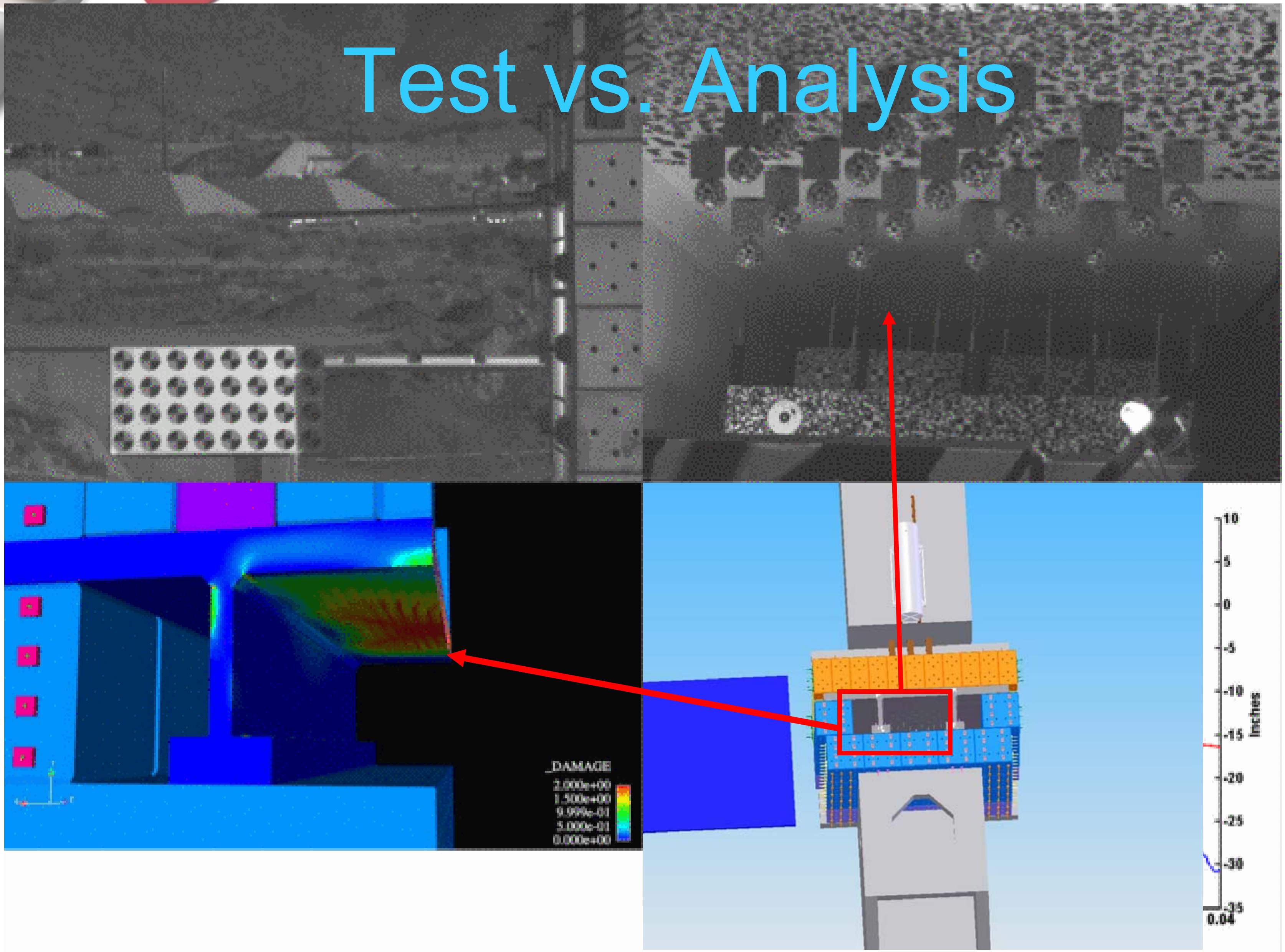
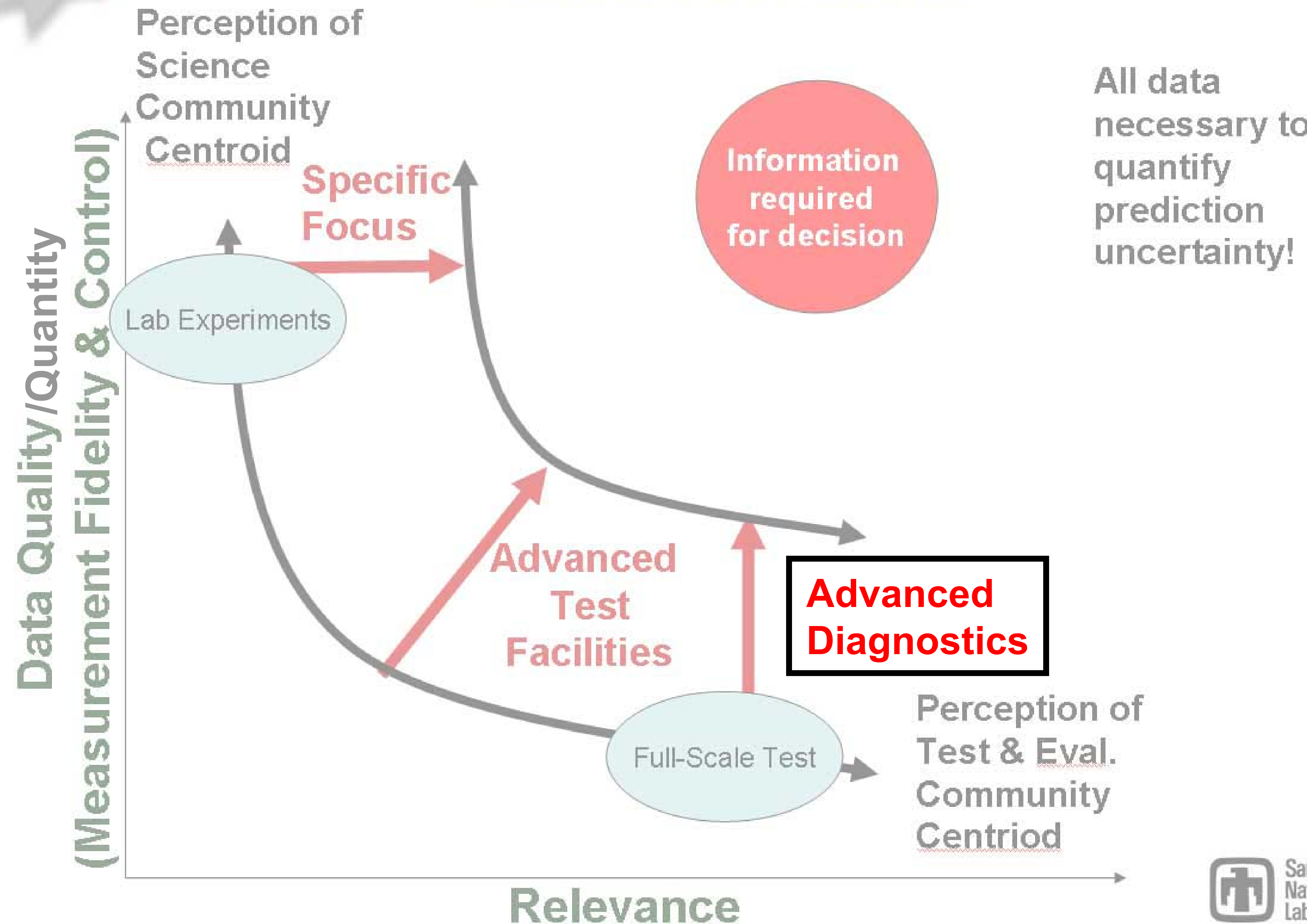
Test vs. Analysis



Simulation **Test Data**

Test and Evaluation is Science in Relevant Conditions



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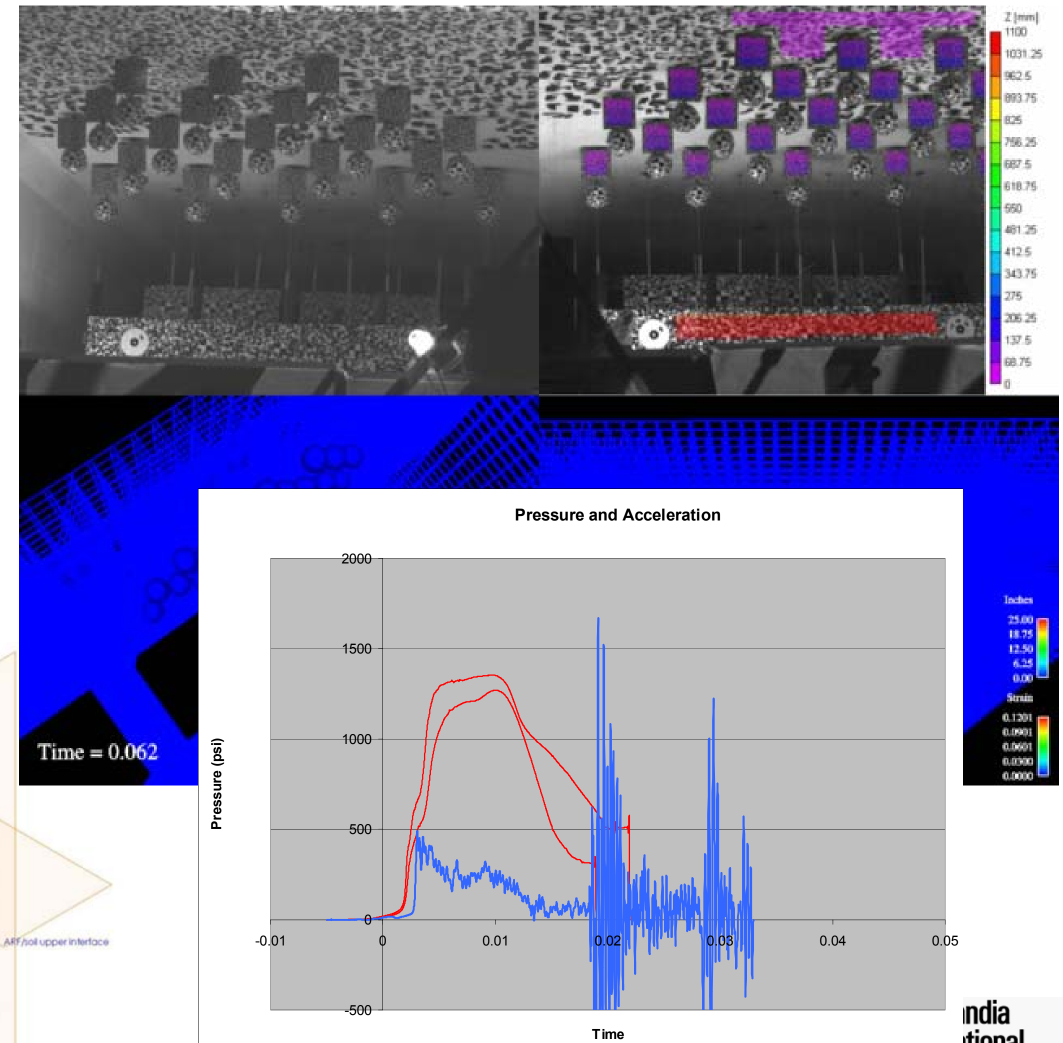
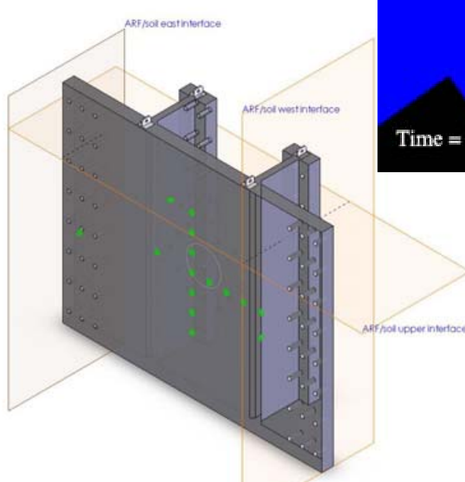
New diagnostic technology demonstrated

- New testing method: “Speckle correlation”
- Provides 3-D full field displacement measurement of structure as it collapses
- Pressure measured at soil/concrete interface to measure pressure in soil
- Pressures were used to validate soil model
- Balls on simulation colored by error



Pressure Gauge Location



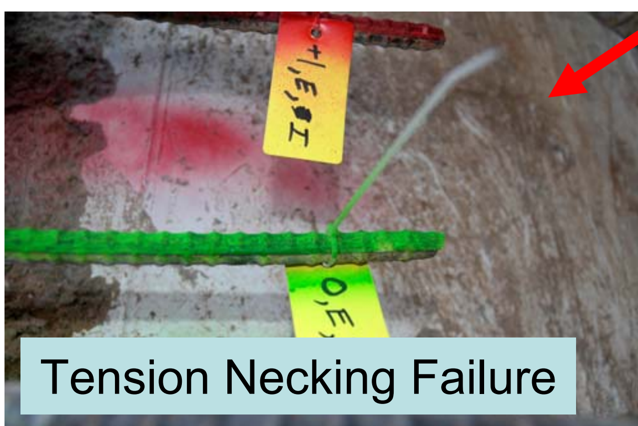
Rebar failure location and timing

Rebar failure location

- 3D FEM models were predicting failure of rebar in compression
- Many features of the test compared well with the pre-test prediction.

Areas of improvement needed based on comparison of the pre-test analysis with test results:

- Rebar failure needs improvement
- Location of rebar failure in pretest simulations were incorrect
- A fully coupled analysis is needed to correctly capture soil pressure as the structure collapses



Tension Necking Failure

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Structural Example Summary

- Testing challenges
  - Too costly to do full-scale structure test
  - Too costly to explore parameters space with relevant reduced-fidelity tests
- Simulation challenges
  - Too costly to do full physics simulations
  - Too costly to reduce uncertainties without tests
- Combination of M&S with T&E provides only realistic path to solution
  - Simulation optimized the parameter space, designed the test, evaluated results
  - Reduced uncertainty in modeling by testing

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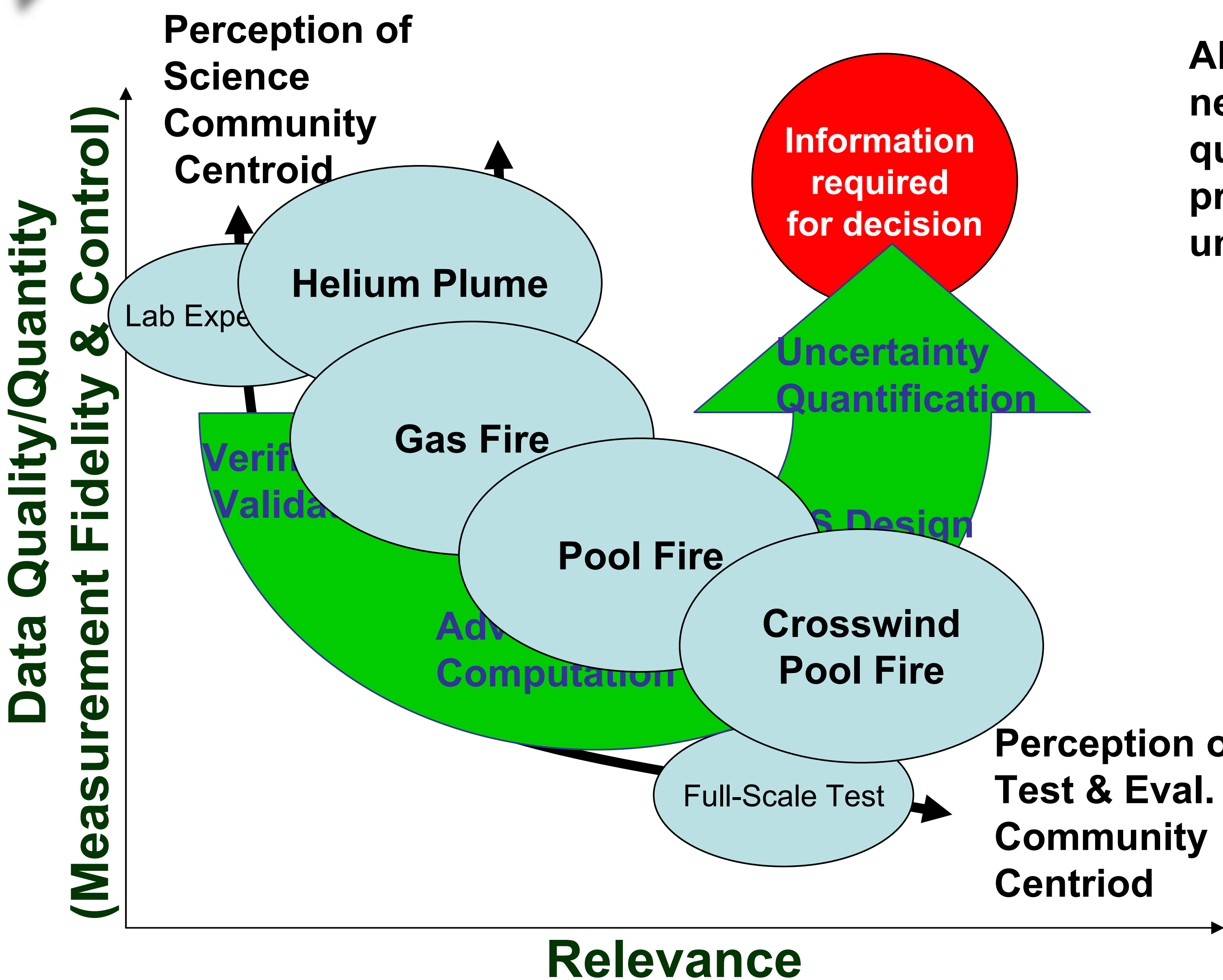
Example #2
Weapon Systems Qualification in Fire Environments

- Validation of numerical simulation
  - Uncertainty quantification for modeling and simulation requires validation data
- Application of numerical simulation
  - Examples showing modeling and simulation greatly aids test and evaluation

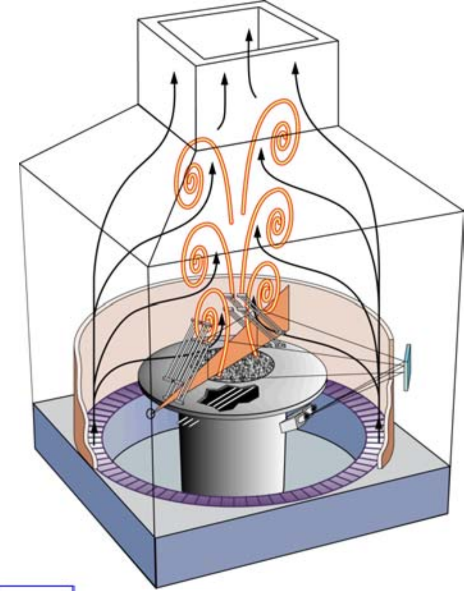
- General comments on cost

Example of validation for fire



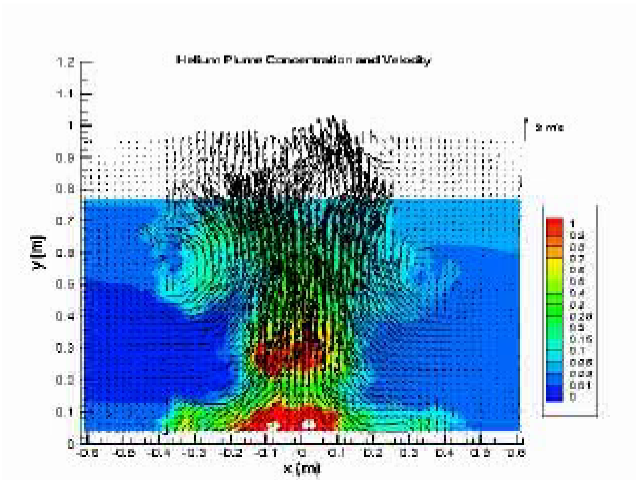
All data are necessary to quantify prediction uncertainty!

Test data establishes prediction uncertainty in plumes

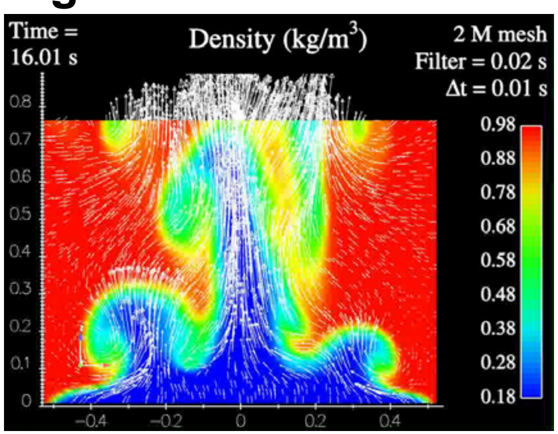


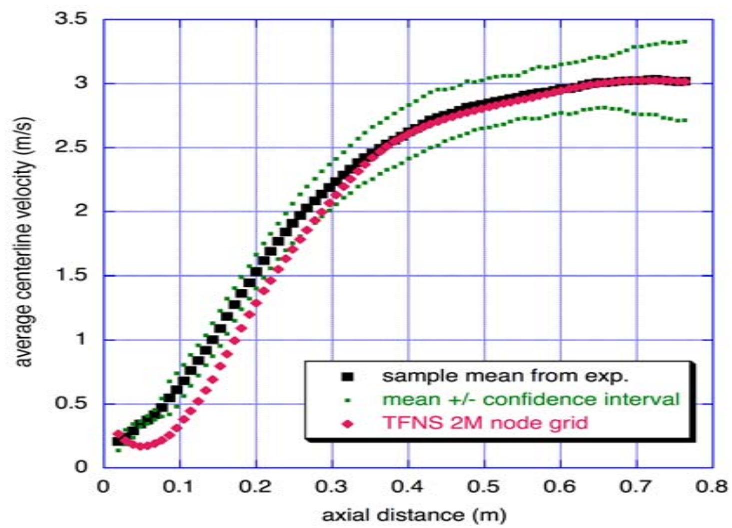
Helium plume - First pair wise momentum/scalar coupling
- 2-D density, velocity and turbulent statistics.

Test Data



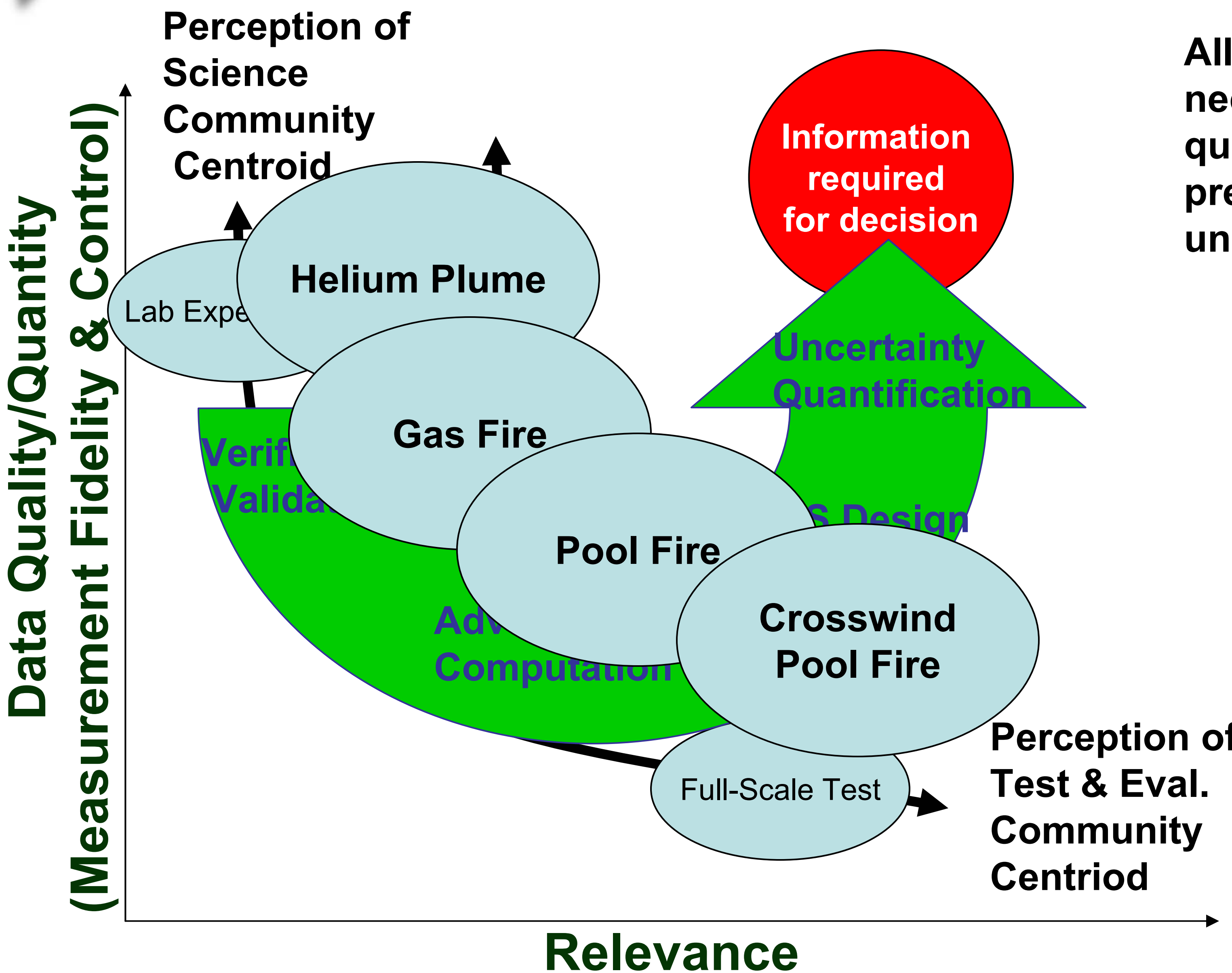
Fuego – 2M node simulation





- Developing quantitative comparison statistics

Example of validation for fire



All data are necessary to quantify prediction uncertainty!

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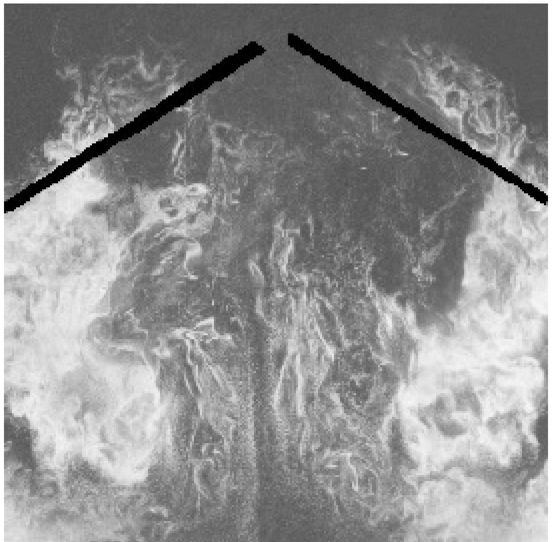
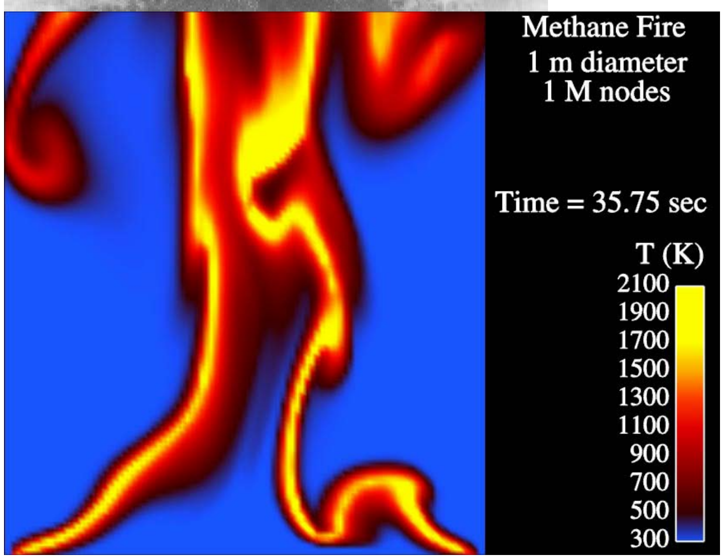
Test data establishes prediction uncertainty in gas fires

- Combusting, non-sooting & sooting gas fires

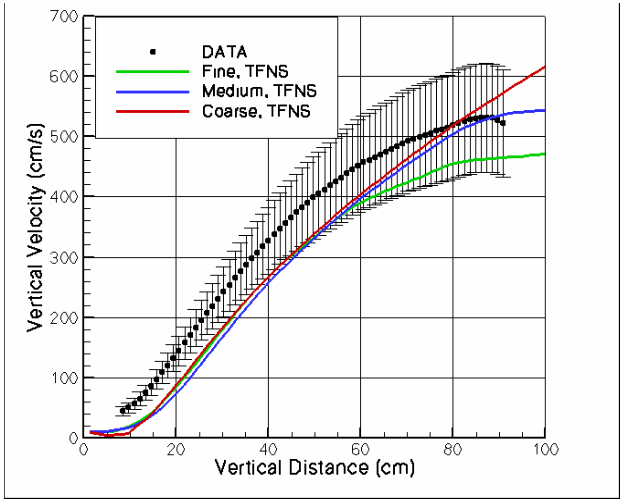
Raw Data

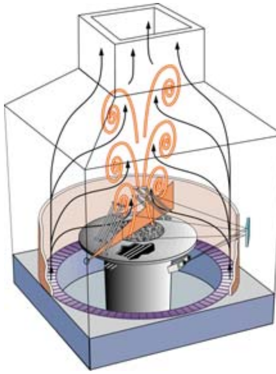


Fuego Simulation

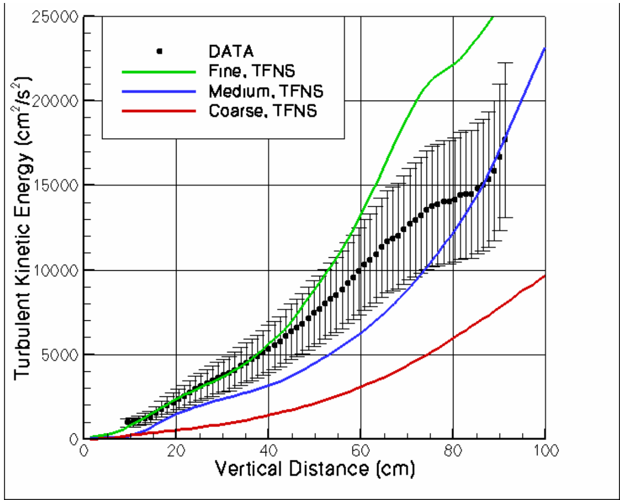


Velocity

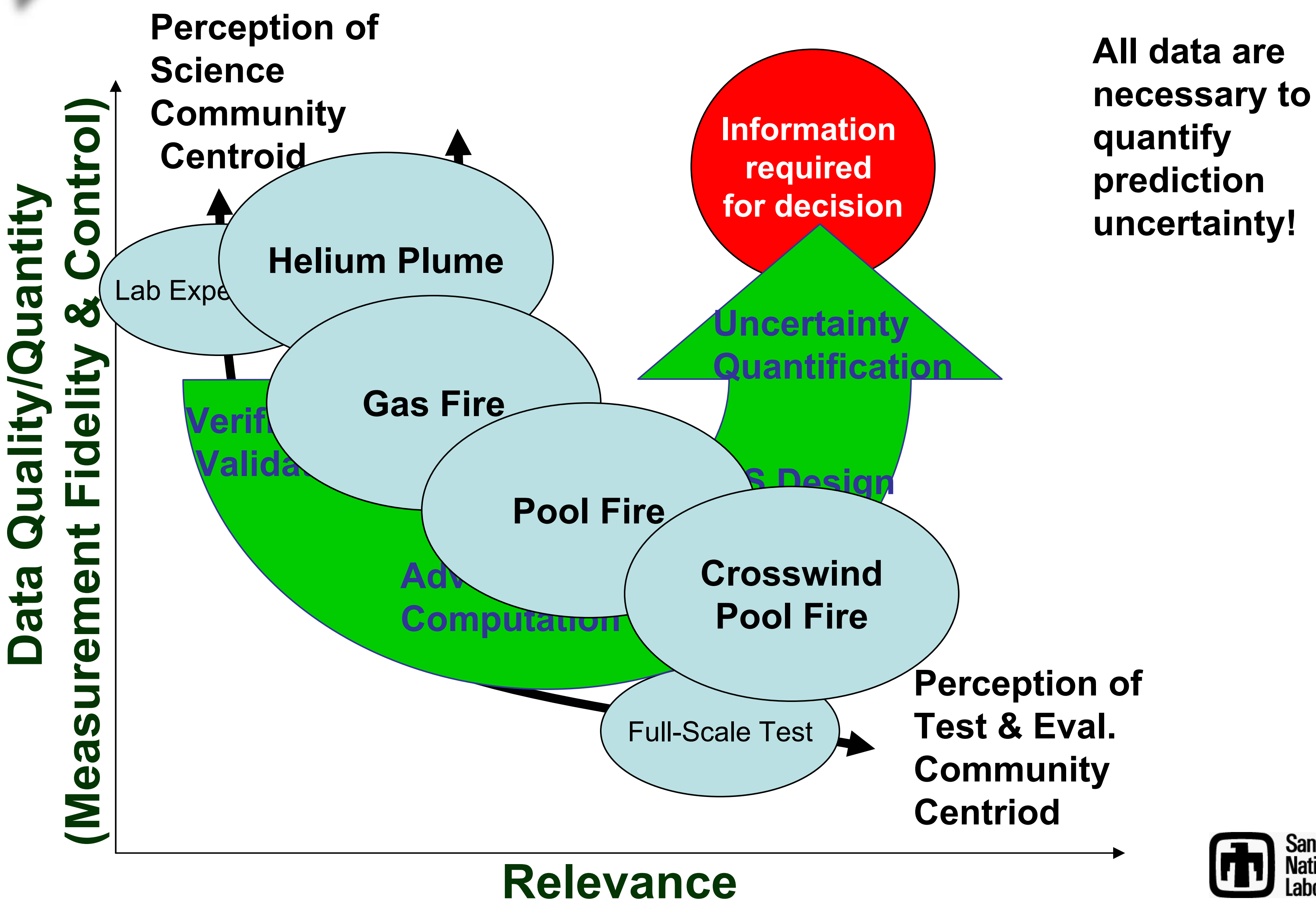




Turbulent Statistics



Example of validation for fire



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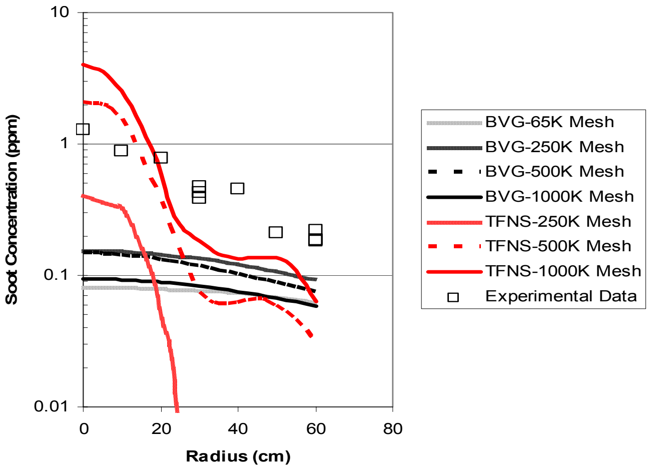
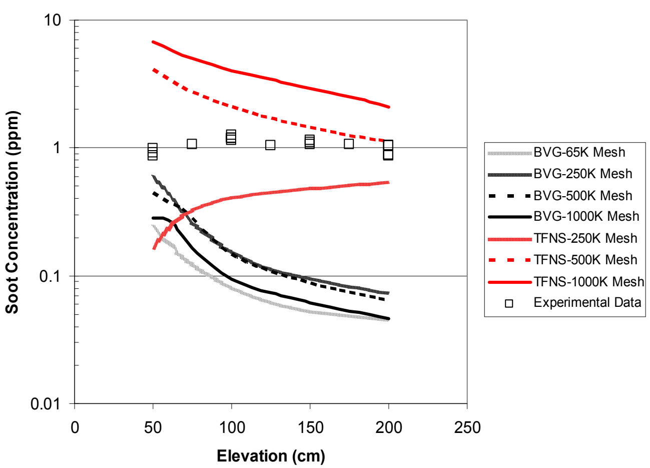
Test data establishes - prediction uncertainty in quiescent pool fires



Radius at 1 m elevation

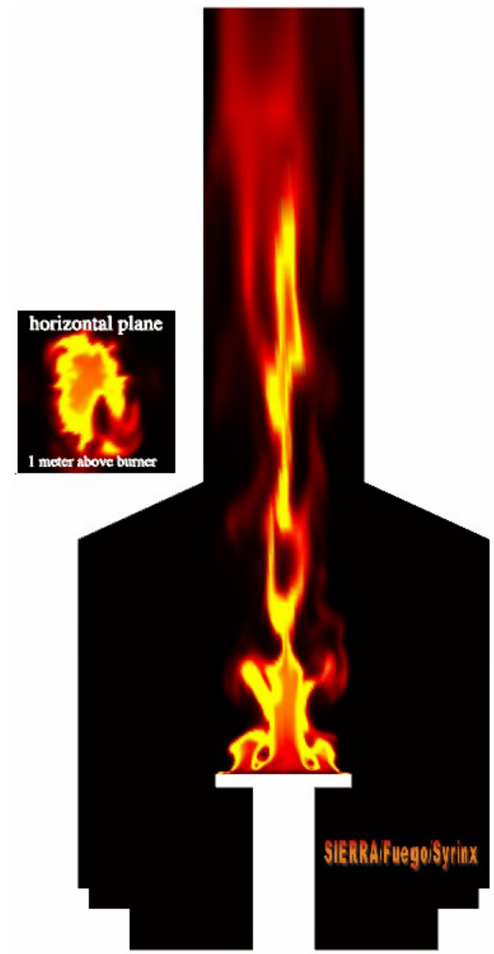
Soot Concentration



Centerline

- **JP-8 2m Dia. quiescent Fire**
- **Soot concentration, a modeled quantity, is not accurately predicted.**

1.2 M node Fuego sim.



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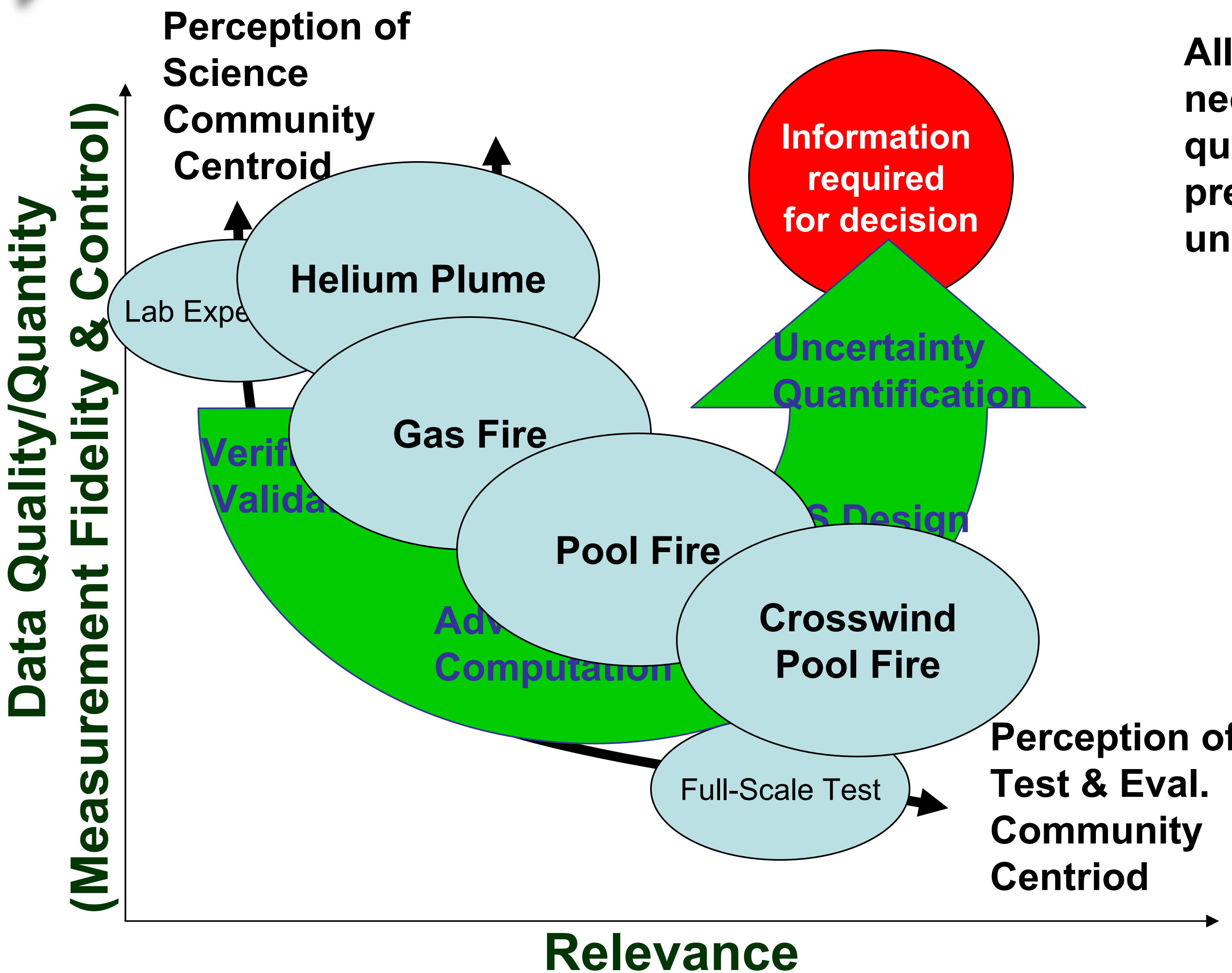
Example of validation for fire



All data are necessary to quantify prediction uncertainty!

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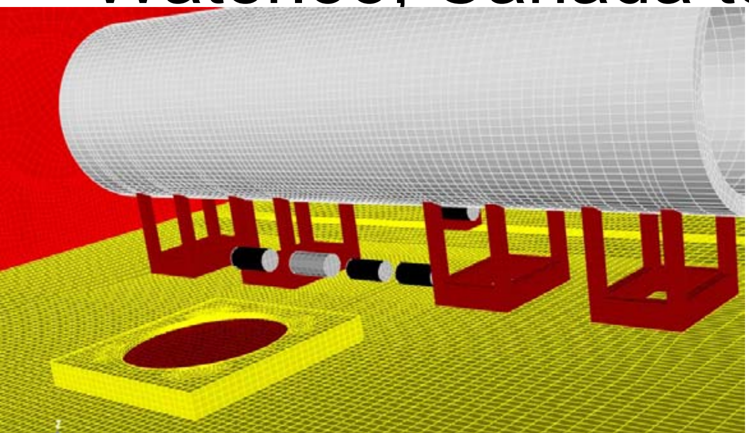
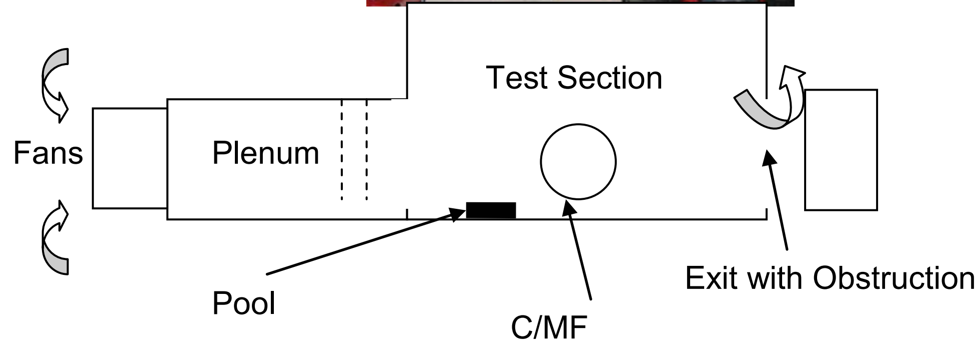
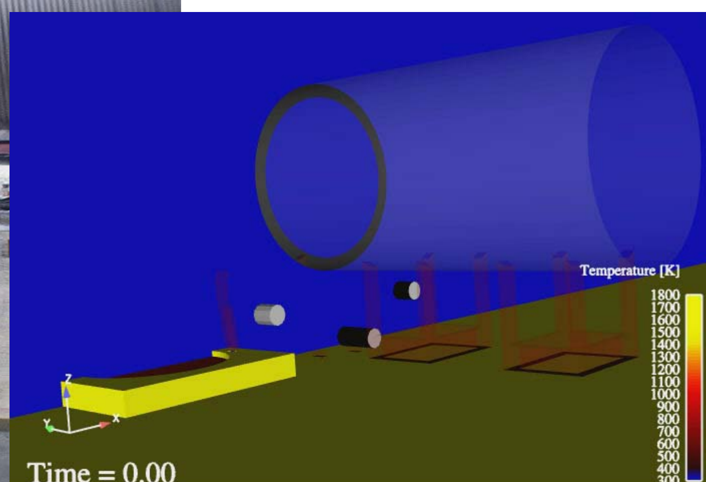
Test data establishes - prediction uncertainty in cross wind pool fires

- JP-8 2m Dia. Cross-Wind Fire Waterloo, Canada test facility







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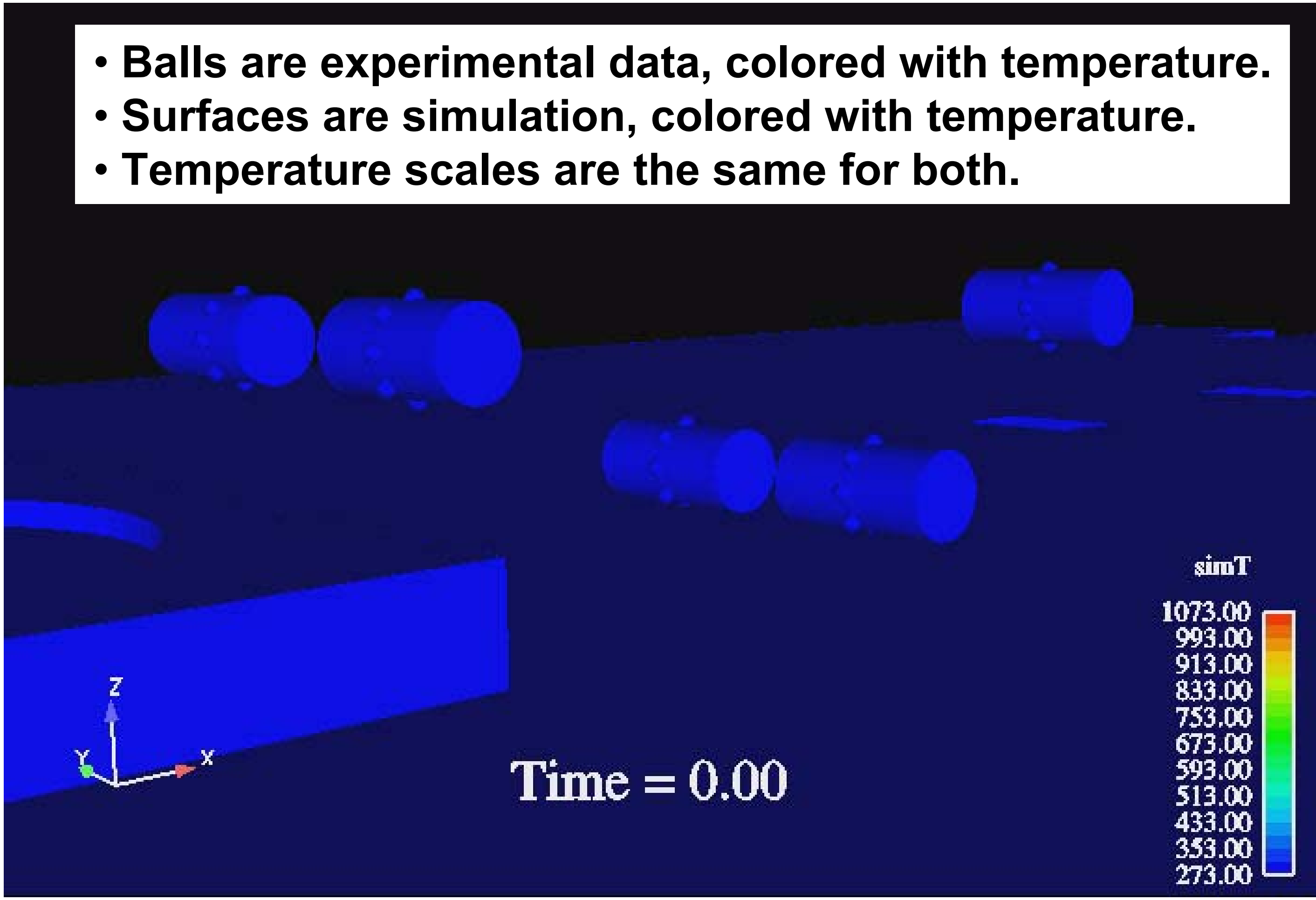
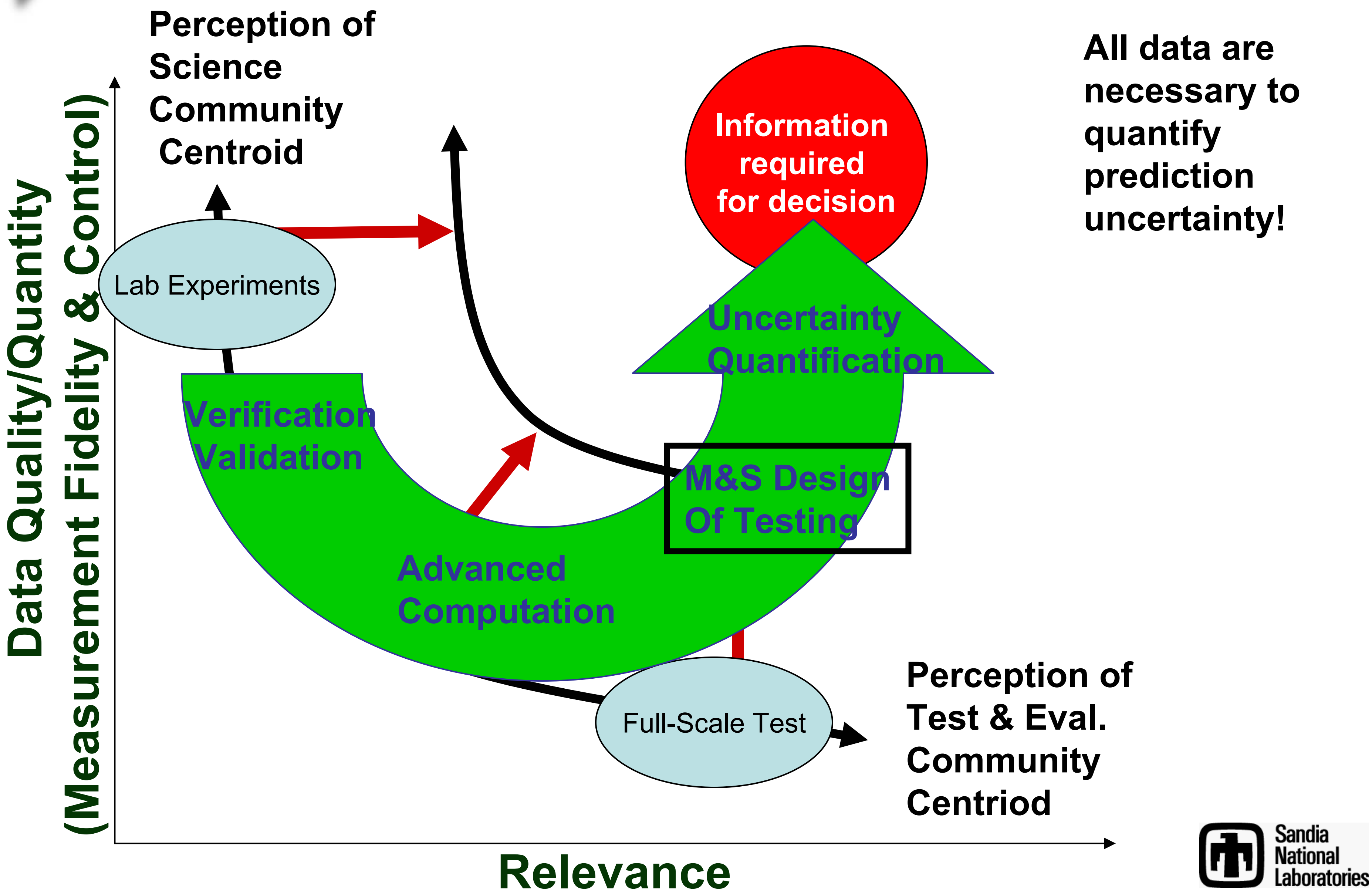
The Challenge of Non-linear Physics Prediction in Relevant Geometries

- Predicting thermal response from fire.
- One calorimeter is thermal response is well predicted, the second is not.
- Sensitivity studies show that fire is predicted strongest on the centerline while test is shifted right.



In this and every example we have run of relevant test problems, the results have given us insight into parameter sensitivities. Quantifying uncertainty in relevant geometries with relevant physics is challenging.

M&S Advances T&E to Decision Goal



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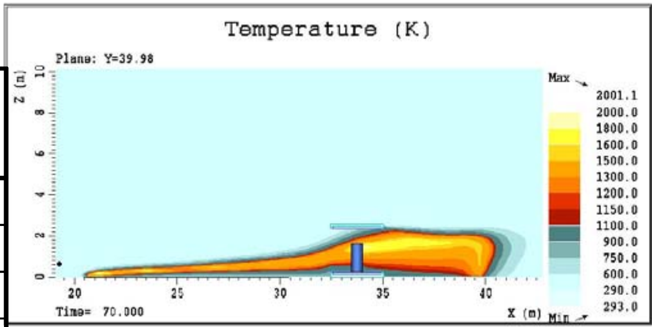
Modeling & Simulation in Support of Weapon System Qualification

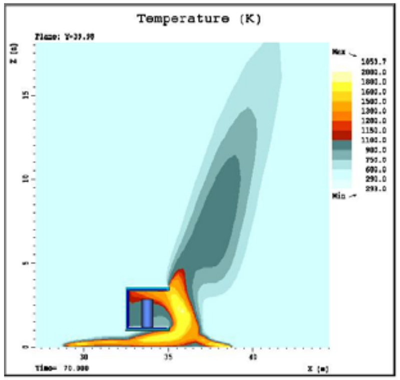
- Challenges
  - Infinite number of accident/incident environments
    - Large parameter space
  - Complex systems have multiple response modes
    - Different loads challenge different modes
  - Different safety & security philosophies
    - Different levels of acceptable outcome

Modeling and Simulation of Large Parameter Spaces

– **M&S strength: Hundreds to thousands of low resolution simulations can conducted**

Case #	Hole Size (m^2)	Fuel Pool Location (m)	Object	Enclosure Height (m)	Pool Size (m)	# of Holes	Wind Speed (m/s)	Peak Heat Flux (kW/m^2)
1	0.47	0	No	1	10	1	2-10	99
2	5.57	0	No	1	10	1	2-10	175
3	3.0	1.85	No	1	10	1	2-10	235
4	0.47	3.7	No	1	10	1	2-10	80
5	5.57	3.7	No	1	10	1	2-10	247
6	3.0	1.85	Yes	1	10	1	2-10	175
7	0.47	3.7	Yes	1	10	1	2-10	72
8	5.57	3.7	Yes	1	10	1	2-10	255
9	5.57	Wind Side	No	0	10	1	2-10	34
10	5.57	Wind Side	No	1	10	2	2-10	200
11a (Case 5)	5.57	3.7	No	1	5	1	2-10	133
11b (Case 13)	5.57	Wind Side (2m up)	No	0	5	2	2-10	266
12	5.57	Wind Side (2m up)	No	1	10	2	2-10	171
13	5.57	Wind Side (2m up)	No	0	10	2	2-10	254





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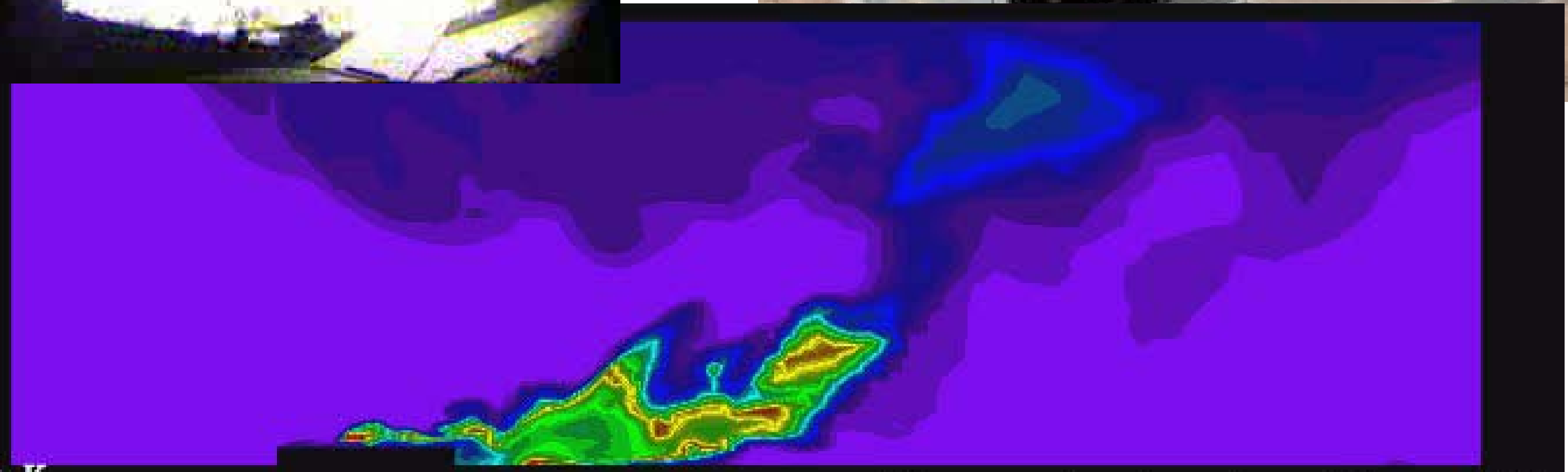
Testing the Selected Scenario

- Test results showed
  - Thermal loads for specified scenario
  - Steady simulations predicted peak heat flux levels but average levels were ~ 50% lower than prediction
  - In spite of our best efforts to control boundary conditions outdoors, wind effects too much to reproduce test for expensive hardware
  - We have very recently moved indoors

Designing a Wind Tunnel for Fires

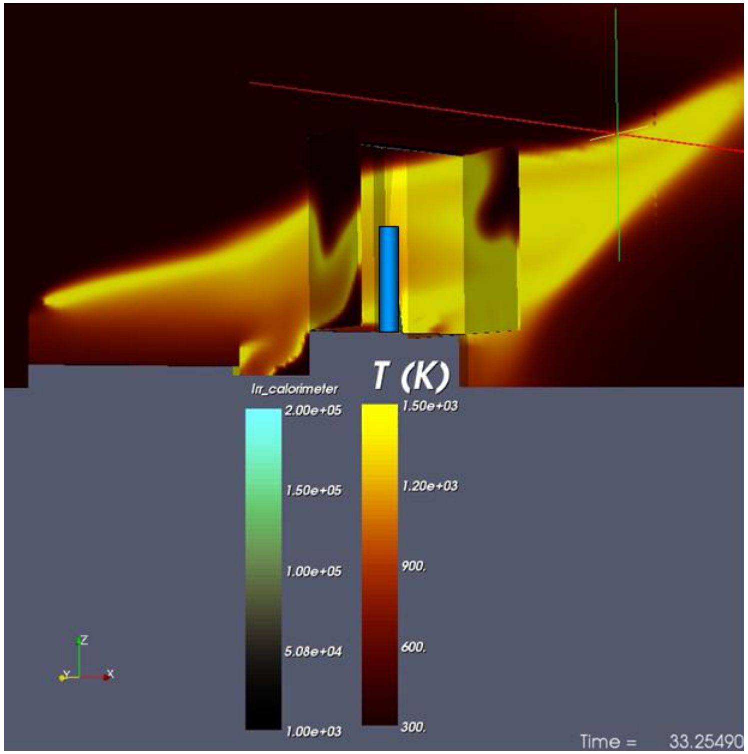
- Desire to reproduce outdoor fires indoors to control boundary conditions.
- Simulations used to design and commission cross-wind test facility

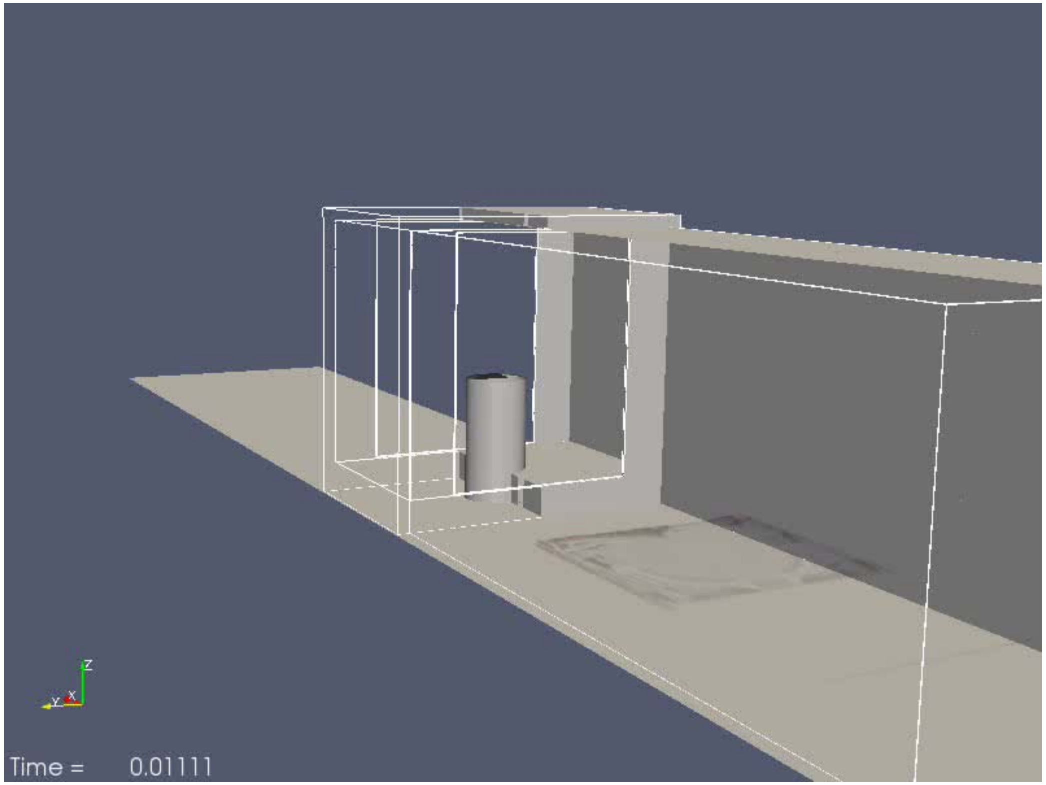
Cross Wind Fire Test Facility



Designing the Indoor Test

- Design with M&S to reproduce the heat flux levels in the outdoor fire.
- Current status: Design is locked and testing is imminent.





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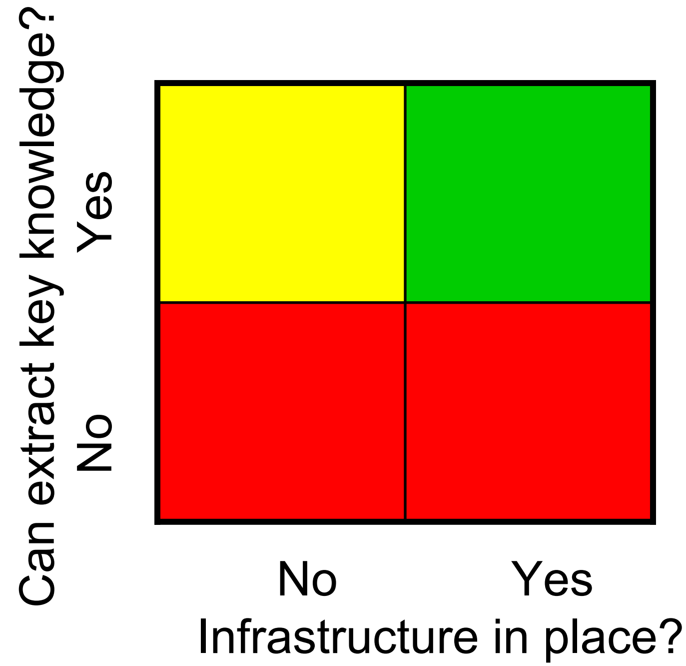
Fire Example Summary

- Testing challenges
  - Too costly to explore parameters space with relevant reduced-fidelity tests
  - Full-scale structure tests are too costly to design with trial and error empirical learning approaches
- Simulation challenges
  - Tests are required for validation to establish uncertainties
  - Uncertainty for complex non-linear physics problems in real geometries is not easy to establish
- Combination of M&S with T&E provides only realistic path to solution
  - Simulation optimized the parameter space and designed the tests
  - Reduced uncertainty in modeling by testing

General Comments on Cost

- Which is cheaper Modeling and Simulation or Test and Evaluation?
  - Both have infrastructure costs, both have use costs
    - In general infrastructure costs are high relative to use costs



  - Either approach can be cheaper
    - Do you have the requisite infrastructure in place?
      - Relatively easy to answer
    - Can you extract the key knowledge?
      - Relatively hard to answer

General Comments on Cost

- Is the combination of M&S and T&E cheaper?
  - In general, no.
    - Infrastructure costs are high and not shared so *cost effectively doubles relative to the cost if the key knowledge can be obtained by single approach*
  - Can the combination be cheaper? Yes
    - With an unknown unknown, what approach will yield the necessary knowledge?
    - Dual track approaches are commonly used to minimize risk when a given approach can fail, but the combination is likely to succeed
      - Optimum dual track approach is one which minimizes common mode failure and maximizes synergy
    - M&S in combination with T&E has highest likelihood to succeed for supporting high-consequence decisions involving system margins
      - The authors contend that neither example given would have been successful with the combination of modeling and simulation

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Summary Experience to Date

- The combination of M&S and T&E is analogous to the well established scientific method.
  - M&S is the current codification of theory.
  - T&E is experimentation under realistic conditions.
- The goal is to have sufficient understanding of the truth to make high-consequence decisions with respect to failure margins.
  - Our experience is that the M&S/T&E combination has yielded much more confidence in our decisions that would be obtained by either approach alone.
  - The approach in the examples is generic and broadly applicable.
- Cost/benefit demonstration for dual track approaches will remain challenging
  - Difficult to establish savings – combined costs appear high if failures are avoided – hard to prove we avoided failure by this approach.

LFT&E

An LFT&E Perspective on Making M&S and T&E Better Partners

Dr. Lowell Tonnessen

Institute for Defense Analyses

Presented at NDIA Test & Evaluation Conference

Jacksonville, Florida

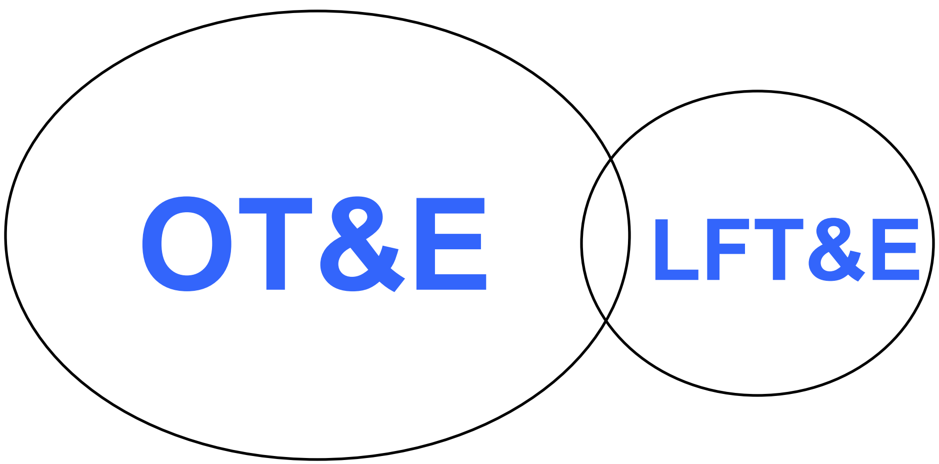
6-9 March 2006

LFT&E

DOT&E Assessments

- **Operational Effectiveness**
- **Operational Suitability**
- **Survivability**

Lethality -- weapons systems and munitions
Vulnerability --manned systems



What Makes LFT&E Different?

LFT&E

- **Operational Tests**
  - Force-on-force
  - Systems operated by typical users
  - Users protected from live fire
- **Live Fire Tests**
  - One-on-one
  - Destructive tests
  - User not on board

Legislative Emphasis on User Casualties

LFT&E

The term 'realistic survivability testing' means…

testing for vulnerability of the system in combat by firing munitions likely to be encountered in combat…

with the primary emphasis on testing vulnerability with respect to potential user casualties….

10 USC 2366

LFT&E

Basic Principles

- It is possible to craft an LFT&E program that does not include modeling and simulation, but probably not wise
- M&S is a tool in support of both test and evaluation, not an alternative to testing

LFT&E

Test & Evaluation

M & S

- Shot selection
- Test sequencing
- Pre-test prediction

- Integration of test results
- Extension to untested conditions
- System-level analyses
- Validation & model improvement

Vulnerability and Lethality

LFT&E

- **Unexpected vulnerabilities, personnel casualties**
- **M&S tends to underestimate lethality, overestimate survivability**
- **Operational lethality vs. parametric lethality**

Validity

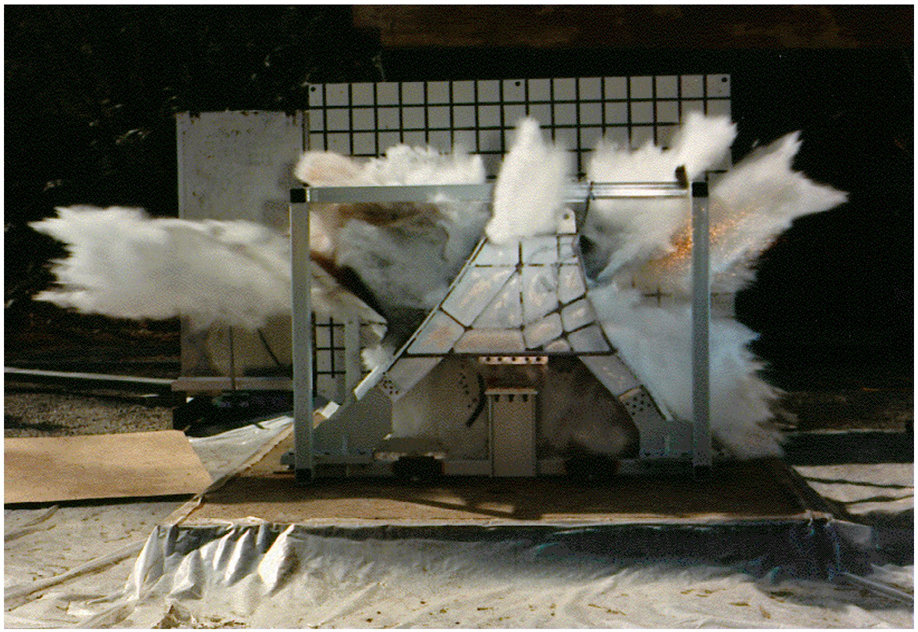
LFT&E

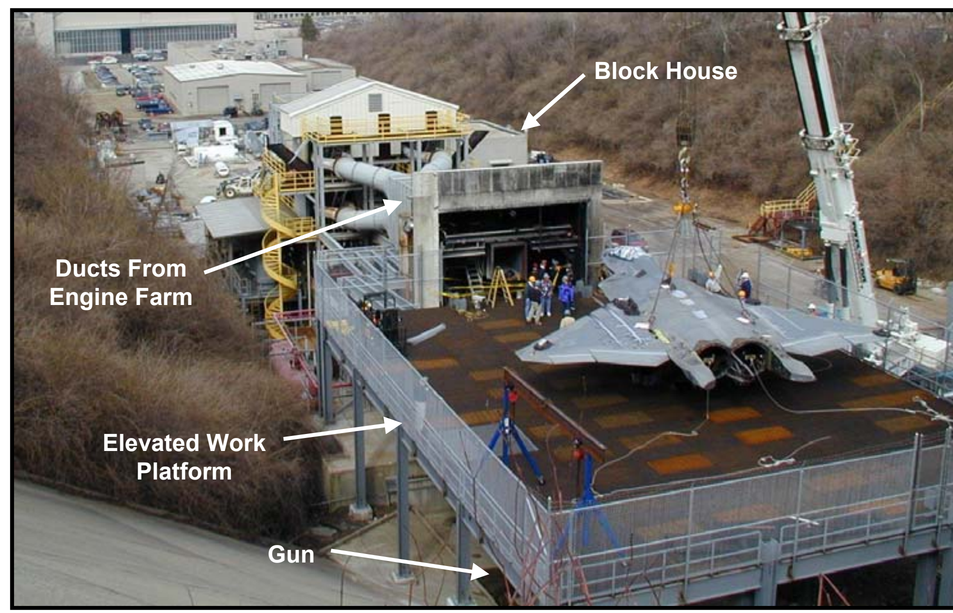
We test in order to validate system performance. We simulate because we cannot afford to test everywhere

"If we don't test, the model is always right." (Jim O'Bryon)

F-22 Wing Section Test

LFT&E





Benefits of M&S?

LFT&E

"Modeling and simulation offers the F-22 program another benefit," Air Force sources said. "Because the Service would control the inputs into the model, the outcome -- proving the aircraft's effectiveness -- is much easier to shape than the outcome of an open air test with any number of unanticipated variables."

Inside the Pentagon, September 1, 1995

LFT&E

Congressional Perspective

- **All sources of data are not equal**
- **A number of laws require testing; few laws require M&S**

LFT&E

Learning and Evaluation

- **M&S is of undoubted benefit in designing more survivable, or more lethal, systems**

Learning and Evaluation

LFT&E

- **Much can be learned from a single realistic event**

LFT&E

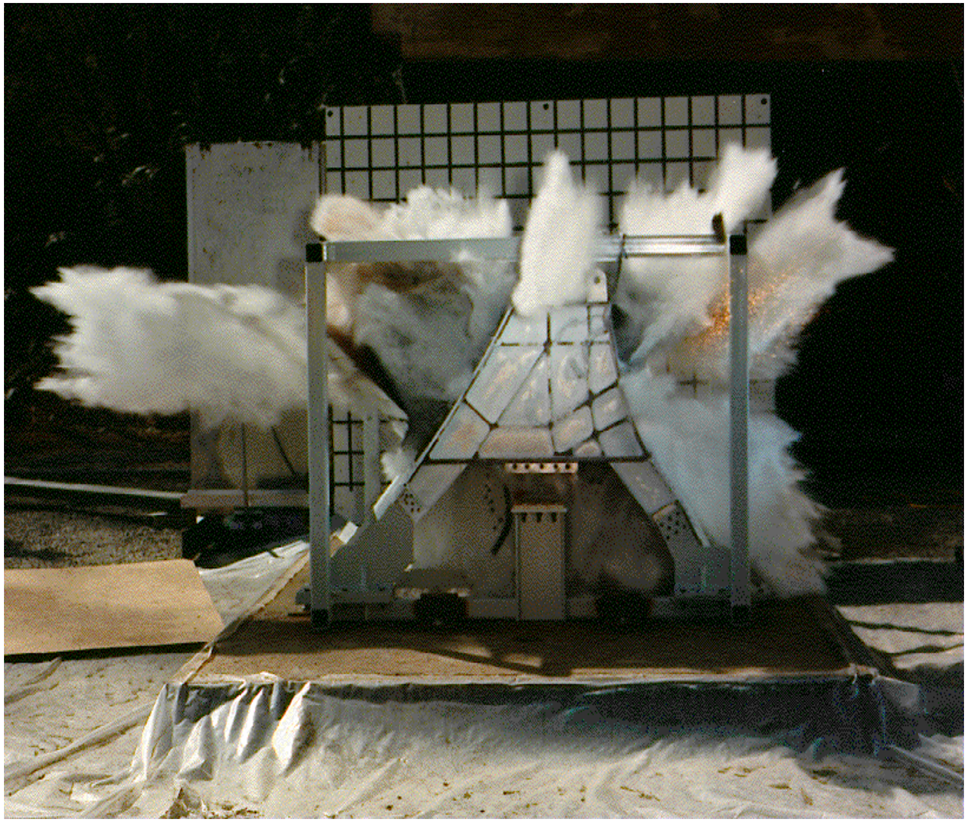
Learning and Evaluation

- **Much can be learned from a single realistic event**

Learning and Evaluation

LFT&E

- **Much can be learned from a single realistic event**



LFT&E

Learning and Evaluation

- **It is misleading to compare relative numbers of test shots and simulated shots**
- **Beware the appeal of “statistically significant” sample sizes based on M&S**
- “Does the model *give* 1000 shots worth of information, or the information from one shot 1000 times over?”

LFT&E

Learning and Evaluation

- Live Fire Testing is limited to a small number of tests, but each one provides the opportunity for surprises
- Surprises occur regularly
- The level of test realism determines the kinds of surprises that are possible

Learning and Evaluation

LFT&E

- **If M&S results are to affect design, the information must be credible at the component level**
- **OSD's M1A1 Abrams Tank LFT&E report noted that the model "…in its current state, would be inadequate for evaluating the effectiveness reduction of design changes. Over half of the critical components damaged leading to a loss of function were either not predicted … or were assessed as rare events…."**

LFT&E

Pretest Predictions

- "We'll know we're successful in live fire testing when the modeling tools we use are so successful that there are no surprises in LFT." (Gen Larry Welch)
- **Surprises are only meaningful in terms of expectations, and expectations are defined by pretest predictions.**

Pretest Predictions

LFT&E

- Pretest predictions do not have to employ computer models
- Predictions should contribute to the planned evaluation
- The prediction should be capable of being compared with the test damage assessment

"In assessing the value of computer models, the "golden rule" applies: a model must predict with higher accuracy than the consensus process (engineering judgment)."

Challenges -- Personnel Casualties

LFT&E

- **Assessment of personnel casualties is increasingly relevant, and presents a major challenge for M&S**
- **Personnel casualties are important in their own right, and not just as a contributor to mission kill**
- **If we expect to make progress towards reducing casualties, we need a means to track that progress**

Challenges -- Ships

LFT&E

- Ship programs are looking for alternatives to full ship shock trials
- M&S will need to be developed to support these alternatives

LFT&E

Other M&S Challenges

- Proprietary M&S
- Integrated survivability M&S (detectability, hit avoidance, vulnerability, recoverability)
- Timely correction of M&S-based estimates to account for test results
- Ballistic M&S

LFT&E

Conclusion

- LFT&E needs M&S to properly evaluate system vulnerability or lethality
- Improvement is needed in several areas
- These include the assessment of personnel casualties, and the integration of vulnerability M&S into an integrated survivability assessment

Mr. Stan Ulkoski

J. F. Taylor, Inc.

(contractor support)

PMA-207D2

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Tactical Air Services

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NAVAIR

CAS MISSION

•Fleet support/DOD – Provide cost effective capable aircraft utilizing commercial, RDT&E prototype and generic EW systems to meet training requirements with no degradation to training.

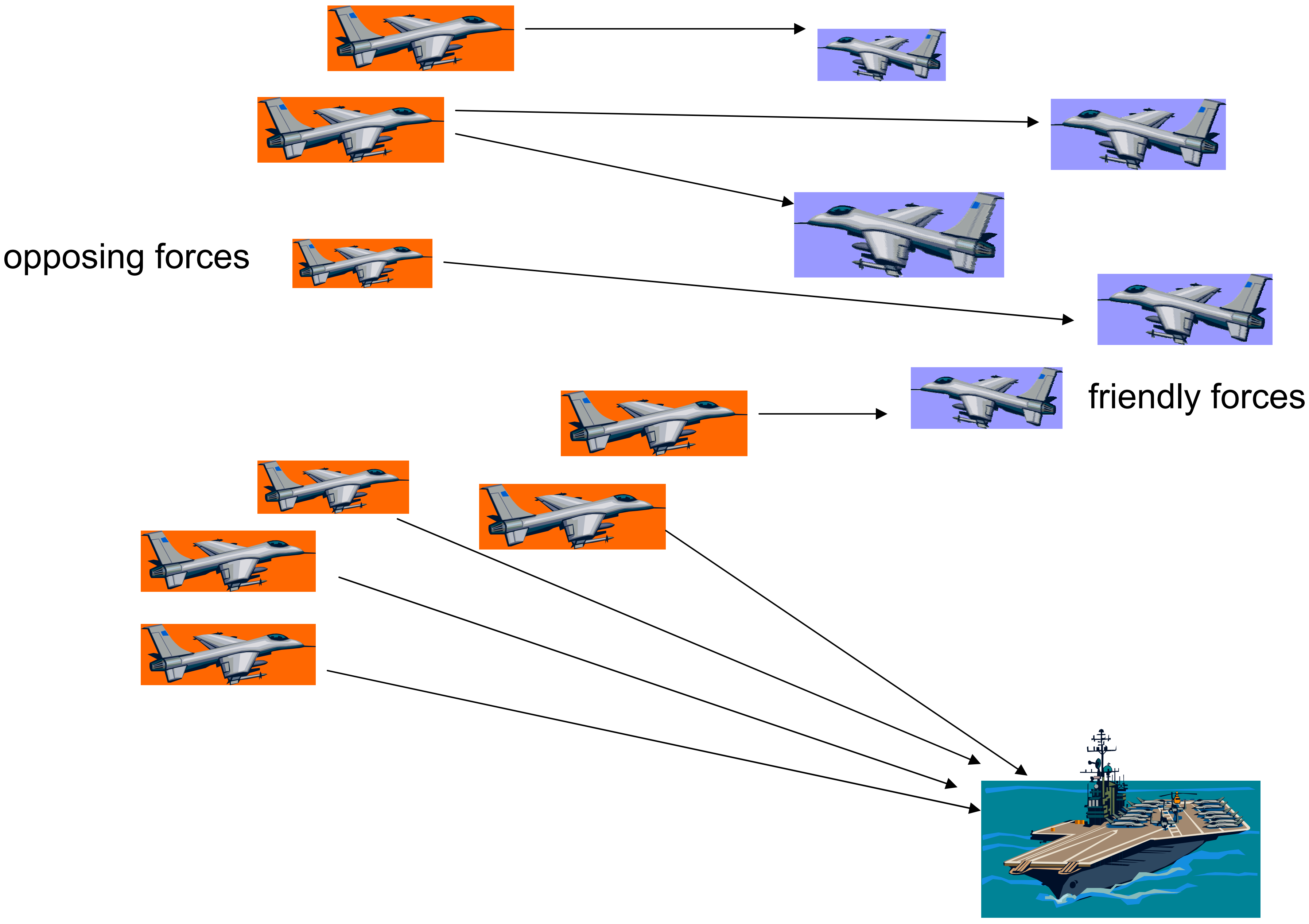
•RDT&E – Provide to the DOD community cost effective aircraft that can be modified to meet advance system development requirements and access to DOD airborne training systems.

National Defense

•PMA-207D2 front line training support.

•Prior to fleet deployment Commercial Air contractors provide OPFOR and ADFOR.

•Missions flown by C/TAS provide the expected hostile environment the battle group will encounter.


opposing forces
friendly forces

Prop	1 aircraft
Lear Jet	12 aircraft
Alpha Jet (4)	8 aircraft
Hawker Hunter (4)	
Kfir	6 aircraft
G-1 Gulfstream	2 aircraft
Tanker	1 aircraft

Total CAS/TAS Fleet support aircraft

30 Aircraft

CONTRACTORS

Contractors:

Flight International, Inc
Newport News, VA
North Island, San Diego, CA
Learjet and Cheyenne

ATAC
Airborne Tactical Advantage Company

Airborne Tactical Advantage Company
Newport News, VA
F-21C2 Kfir/Hawker Hunter

Omega Aerial Refueling Services, Inc
Alexandria, VA
KC707 Tanker

OMEGA AIR

Phoenix Air, Inc
Cartersville, GA
G-1 Gulfstream

Air USA, Inc
Quincy, IL
Alpha Jet

WHY COMMERCIAL AIR SERVICES???

1. Over 20 years of RDT&E experience, working with FAA, contractors, and DOD agencies
2. Central point for air assets
3. Cost effective aircraft and EW support systems
4. 97% Mission completion rate
5. Contract in place
6. Small foot print
7. Majority of the pilots are former military
8. Engineering in house
9. Global support
10. Financial tracking provided

WHY COMMERCIAL AIR SERVICES???

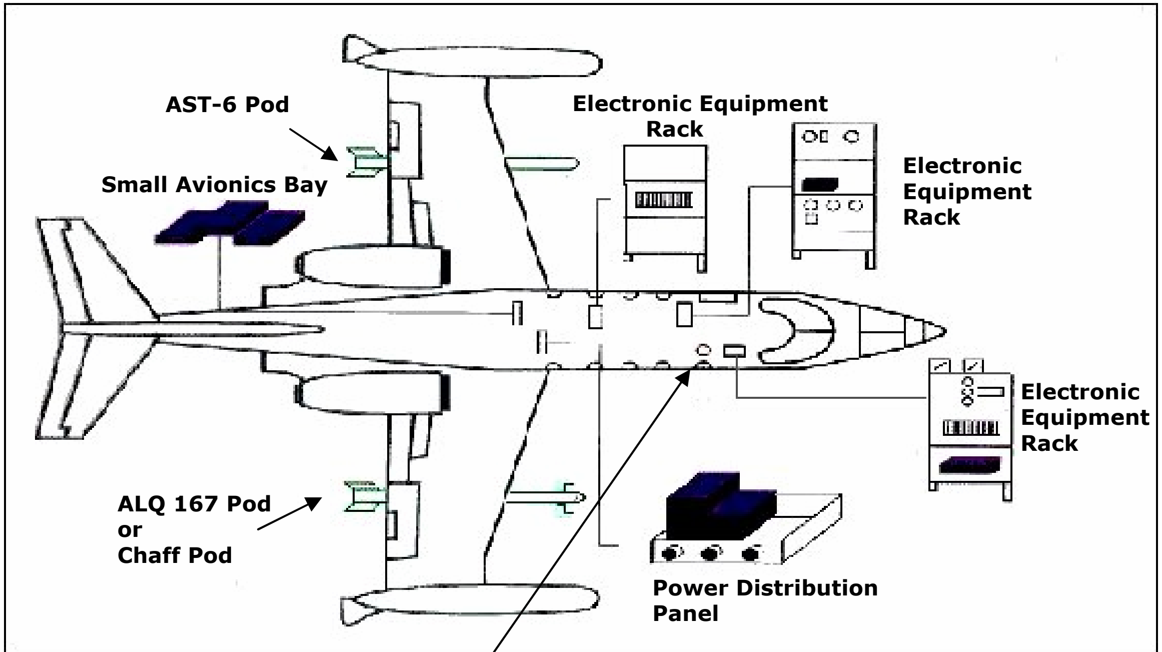
- OPSEC capable
- In-house or can access: EA / ECM / threat sim / chaff pods, tow targets, and prototype EW systems

14. Extensive electronic warefare experience in military training, RDT&E and contractor RDT&E

15. FAA certified (STC, DER, Form-337 capable)

16. Available to government agencies and civilian contractors supporting government projects

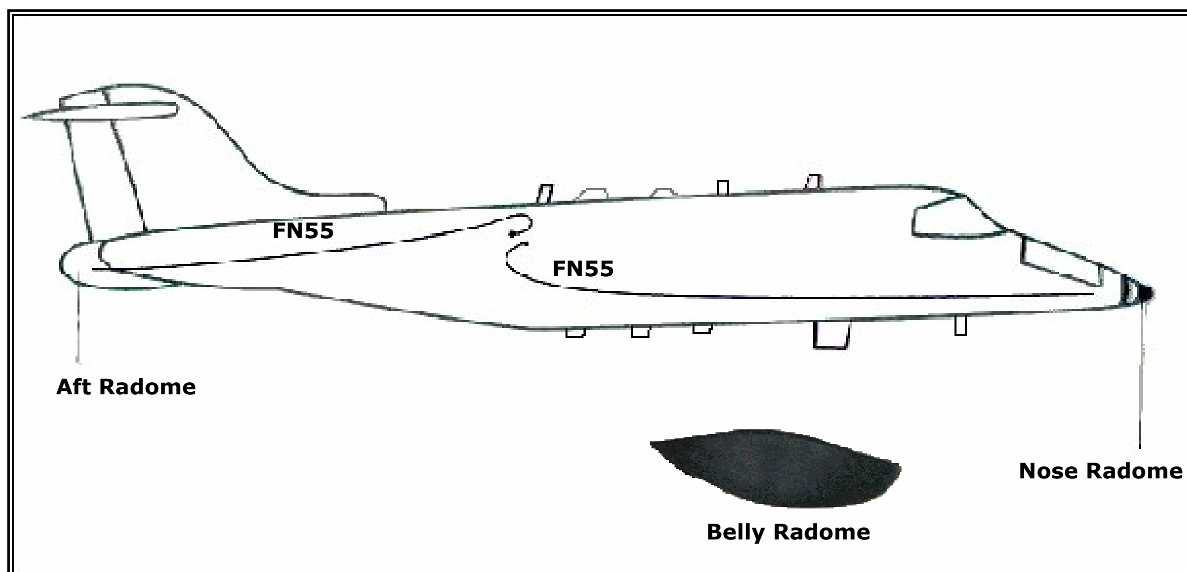
Airborne Lab Configuration



Available:

DGPS
A/C Pitch-Roll Heading Altitude

Test Operator/Test Engineer Station
UHF Radio (independent of cockpit)
Comm with air units and/or ground units



WORLD-WIDE SUPPORT
DOD and RDT&E

LOCATIONS SUPPORTED
PERMANENT BASING

North Island, CA
Pt. Mugu, CA
Learjets / Alpha Jets

Newport News, VA
Learjets / Kfirs / Hawker Hunters

Seattle, WA

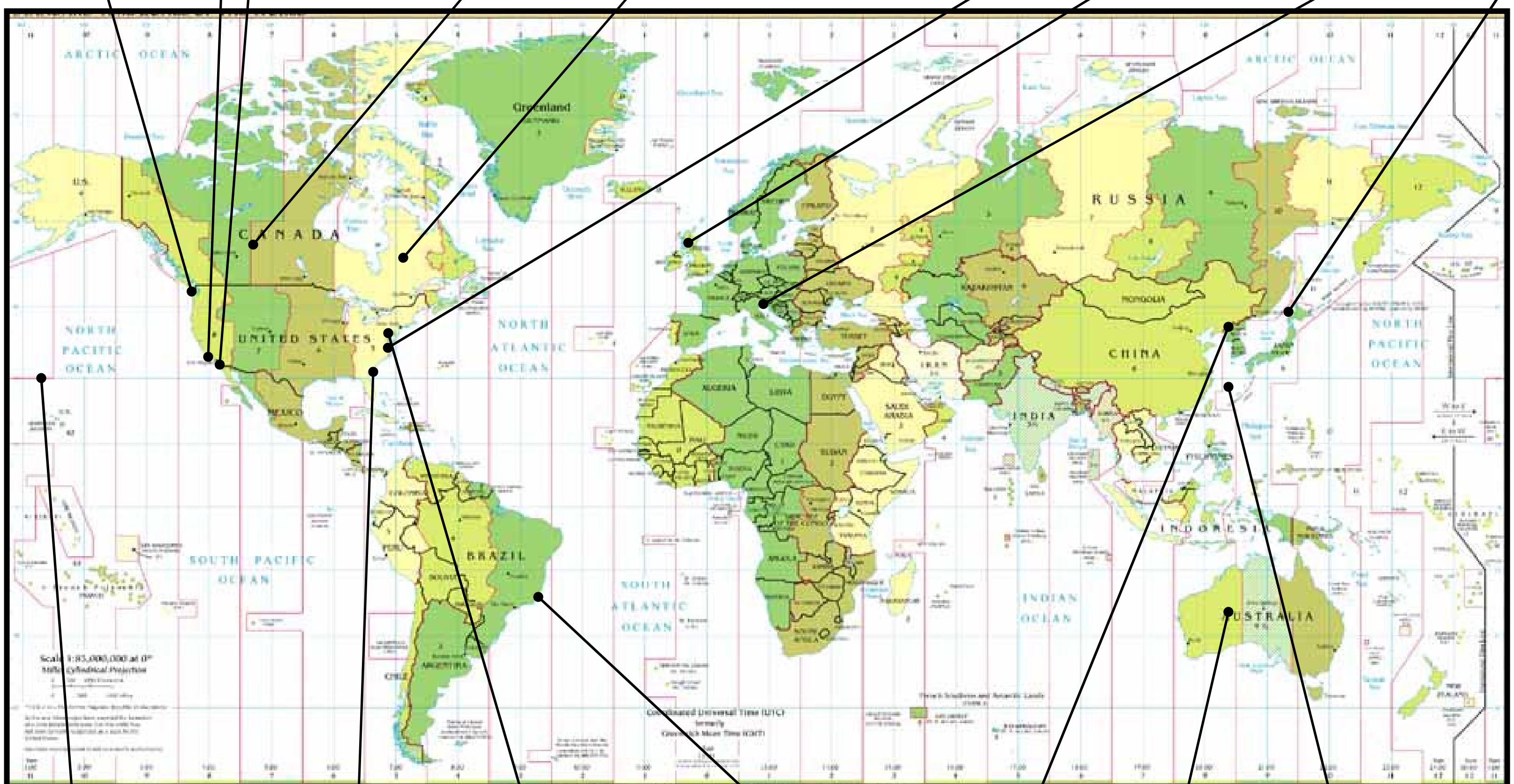
Cold Lake, CANADA

Quebec, CANADA

SCOTLAND

Naples, ITALY

JAPAN
Alpha Jets



HAWAII
June 06: Alpha Jets

Cartersville, GA
G-1 Gulfstream

Patuxent River, MD
Tanker

Rio de Janeiro, BRAZIL

KOREA

AUSTRALIA

Det to Okinawa, JAPAN

QUESTIONS ???

www.electwarairc.com

T&E Transformation

We Don't Need a More Formal Invitation

William P. Yeakel

wpy@orsacorp.com

Full Spectrum Solutions

ORSA corp

“Far more than just materiel solutions, Army Transformation is a multidimensional process which involves adapting new technologies to war fighting; developing improved Joint Operating Concepts and business processes; changing organizational structures, and developing leaders, people, and a culture that are relevant to the future. It's important to remember that Army Transformation is not an end state; it is a continuous journey in which the Operational Army and the Institutional Army adapt to an ever-changing operational environment. As such, Army Transformation is ingrained in everything we do - today, tomorrow and forever.”

Francis Harvey, SECARMY

"We recognized that to put weapon and system capabilities quickly into the hands of the warfighters, we could not conduct business as usual."

MG James R. Myles, CG ATEC

Current Situation

- Global War on Terror
- Tightened schedules
- Greater competition for resources
- Emphasis on jointness
- Facilities, equipment & personnel under stress
- Changing players, roles & responsibilities

What About M&S

- Delivery consistently falls short of promise!
- T&E community faced with greater risk!
- T&E community largely unfamiliar with Army and Joint models/simulations!
- Expensive, not always cost effective!

Causes

- Model developers have different objectives
- Greater M&S expertise needed in T&E community
- Lack of real M&S understanding at senior levels throughout DOD
- T&E is often an after-thought for M&S world

Recommendations

- Invest in M&S education
  - Learn how and when to use M&S
  - Learn when not to and why
  - Understand data requirements/implications
  - Know the language
- Put T&E requirements on M&S developer's table early in process
- Focus M&S on managing T&E risk

More Recommendations

- Employ a consistent framework in T&E approach.
  - MMF or something like it is essential particularly for Systems of Systems
  - Complexity and interdependence of issues too great otherwise

- Listen to Army CoS and SECARMY
  - Ask yourself and your boss how you can support the soldier more effectively
  - Learn about and use Lean Six Sigma approach and force M&S to support efficiency without sacrificing effectiveness

Thank You!

Finally, despite the fact that what I have said may focus on areas where we need to improve, I believe that you are providing tremendous support for the men and women serving our country in uniform.

Thank you for what you do and the passion with which you do it!

Questions?